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U. S. DEPARTMENT OF AGRICULTURE.

Report No. 73.

REPORT

OF THE

SECRETARY OF AGRICULTURE.

1902.

WASHINGTON:
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REPORT

OF THE

SECRETARY OF AGRICULTURE.

To THE PRESIDENT:

The educational work of the Department of Agriculture has grown in effectiveness since my last Annual Report. The opportunities offered to young men to fit themselves for special lines of experimental work under the immediate care of our most experienced scientists are being sought by greater numbers every year. The influence of the Department is extending through cooperation with the scientists of the experiment stations of the several States and Territories and the isles of the sea under our flag. The demands of these institutions for trained men to conduct research into so many fields of inquiry and of private individuals and companies for the best organizing and supervising ability to manage agricultural enterprises encourage students to prepare for doing this work.

The teaching of the science of agriculture and the sciences related to it is receiving more attention in the colleges instituted for this purpose, many of which in the past have neglected their full duty in this regard.

Research by the Department officials into the principles governing the growth of plants and the creation of new species by hybridizing to give varieties from which to select for new purposes has brought gratifying results. We have new fruits and grains of numerous kinds adapted to localities that have been needing them for many years.

We are helping people in many localities to an intelligent knowledge of their soils and of the most profitable uses to which they may be devoted. Results are showing the value of this service. The best sugar lands, rice lands, tobacco lands, truck lands, and lands best adapted to particular fruits, grains, grasses, legumes, and other crops are being discovered as certainly as any other unknown thing is brought to human knowledge for the first time.

Few of the plants of most value to our people are native to the United States. They are products of other countries and have been useful in their localities for long periods of time. Our various soils and climates are adapted to many things that have not yet been introduced to them. Department explorers are searching the Old World for whatever is valuable there and useful here, with results that are quite encouraging. Our aims are to help toward the production in the States and Territories of everything their soils and climates will permit, and to help our new island possessions to grow whatever products require tropical conditions.

Our growing commerce is accompanied with danger from invasion of animal and plant diseases and parasites calling for vigilance on the part of Department scientists to keep them out and to deal with them when they cross our borders, as they occasionally do.

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My last Report showed that the Department was paying $12,600 a year for rent of buildings. It is now paying $21,700, and the amount will increase as the work increases. It would be good business policy to adopt a plan of building adequate to the future needs of the Department, and to authorize the erection of so much of it as would provide for the offices that are now housed in the city wherever room can be had. The sum necessary to provide the rent, at Government rates of interest, would be ample to begin with; besides none of the buildings now in use are fireproof, and we have materials that have accumulated in our laboratories, in addition to a unique library, that could not be replaced if destroyed by fire.

WEATHER BUREAU.

Forecast Warnings.

The past year affords gratifying evidence of the value of forecast warnings of the Weather Bureau in saving life and property. People of other nations express appreciation of our Atlantic weather forecasts. The universal appreciation of this service in giving ample warning of the approach of severe storms or hurricanes or of killing frosts is highly gratifying and affords ample testimony of the assertion I have made on previous occasions that the value of property saved from loss repays to the country many times over the cost of maintaining the Bureau.

Substantial increase was made in the distribution of daily forecasts through the rural free delivery, although efforts in this direction were circumscribed for want of funds for the purchase of necessary supplies. On August 1, 1902, there were in operation about 10,000 rural free-delivery routes, serving approximately 1,000,000 families. For the reason stated, only 105,000 families, served by about 1,000 routes, could be furnished with the forecasts of the Bureau. According to the estimates of the Post-Office Department, there will be in operation July 1, 1903, 15,000 routes, serving approximately 1,500,000 families, representing a population of over 7,500,000 people. The distribution of the daily forecasts of the Bureau should be made coextensive with the rural free delivery. This could be done on the basis of the Post-Office estimates for July 1, 1903, at a cost of about $100,000.

Wireless Telegraphy.

The experiments in space, or wireless, telegraphy were begun January 1, 1900, under the direction of the Chief of the Weather Bureau, and were continued during the past year. While much valuable information has been secured and a fairly satisfactory experimental system has been devised, I am not able to report such progress in the investigation as would justify the Department in dispensing with its coast telegraph lines or with the cables that connect certain islands with the mainland.

Storm Warning Equipment.

As far as funds would permit, the work of extending the equipment of steel towers and high-power lanterns of improved type at important storm warning stations was pushed energetically during the year by the instrument division. In all, 54 towers were distributed to storm warning stations.

The funds available were too limited to permit of the purchase of high-power lanterns and other accessories required by the towers.

Moreover, the first six months of the past year have been necessarily consumed in the manufacture, shipment, and installation of the towers. The matter of lanterns and accessories will therefore have to be supplied this year, and while provision for them has already been made, the storm-warning fund will permit of no considerable extension of the work, and we must of necessity confine ourselves to finishing up the work left over from last year. There are now 109 storm-warning and 9 special stations at which the steel towers have been installed. Of these, 48 need lanterns, and they will be issued as soon as delivered by the contractors.

Under the special appropriation by Congress for the purchase of sites and the erection of buildings for the use of the Weather Bureau at certain stations, buildings were erected at the following places, at a total cost of $23,932.53, namely: Atlantic City, N. J.; Hatteras, N. C.; Fort Canby (North Head), Wash.; Port Crescent, Wash.; Tatoosh Island, Wash., and Point Reyes, Cal. Under this appropriation, also, buildings were repaired and improved and supplies provided, at a cost of $17,279.03, at the following places: Bismarck, N. Dak.; Jupiter, Fla.; Kittyhawk, N. C., and Cape Henry, Virginia. The buildings at Port Crescent, Wash., and Jupiter, Fla., are still in course of construction, but will be completed within a few months. In view of the approval of this policy and of the economy to the Government of owning its own buildings, I recommended an additional appropriation of $50,000, which was duly granted by Congress, for the purchase of sites and the erection of not less than six buildings during the current fiscal year. The places selected for these new buildings are Yellowstone Park, Wyo.; Amarillo, Tex.; Modena, Utah; Key West, Fla.; Sand Key, Fla., and South Farallone Island, California. Owing to the difficulty in providing sites for the buildings at Amarillo and Modena, it will hardly be practicable to erect buildings there before next spring.

The crop service of the Bureau will be dealt with in a special report called for by Congress.

BUREAU OF ANIMAL INDUSTRY.

Inspection Service for Export Animals.

The act of Congress of August 30, 1890, provided for the inspection by the Bureau of Animal Industry of meats for exportation, and this was supplemented on March 3, 1891, by an act providing "for the inspection of live cattle, hogs, and the carcasses and products thereof which are the subjects of interstate commerce, and for other purposes." This law was amended by an act which took effect July 1, 1902, providing for the inspection of dairy products for export. Under these laws important service to the live-stock industry has been performed.

The total number of ante-mortem inspections was 59,158,648, being an increase over the previous year of 2,789,338. The cost of these inspections was 1.08 cents each. The number of post-mortem inspections was 38,903,625. The carcasses condemned numbered 61,980, besides 17,445 parts of carcasses.

The meat-inspection tag or brand was placed upon 19,694,665 quarters, 250,141 pieces, and 3,820 sacks of beef, 7,419,287 carcasses of sheep, 554,016 carcasses of calves, 1,253,083 carcasses of hogs, and 793,471 sacks of pork.

The meat-inspection stamp was affixed to packages of meat products that had received the ordinary inspection as follows: 7,166,490 of beef,

39,229 of mutton, 8 of veal, 15,835,520 of pork, and 638 of horseflesh, a total of 23,041,885.

The number of cars sealed containing inspected meat products for shipment to official abattoirs and other places was 64,730.

The number of certificates of ordinary inspection issued for meat products for export, exclusive of horseflesh, was 32,744. Of beef there were 1,571,305 quarters, 19,728 pieces, 3,845 bags, and 1,582,549 packages, with a weight of 416,990,762 pounds; of mutton there were 85 carcasses and 26,942 packages, weighing 1,145,248 pounds; of pork there were 94,962 carcasses and 658,139 packages, weighing 188,360,011 pounds. These figures show a decrease from the previous year of 35,839,611 pounds of beef and 42,784,927 pounds of pork. There were 11 certificates issued for horseflesh, the export consisting of 638 packages, weighing 170,968 pounds.

The quantity of pork examined microscopically, which was exported, amounted to 33,681,229 pounds. This was a decrease of a little more than 2,000,000 pounds from the previous year, owing to a decreased demand for pork from those countries demanding inspection. The cost of this work per pound was 0.368 cent.

The value of the exports of animals and animal products for the year ended June 30, 1902, amounted to the large sum of $244,733,062. Of this amount, $44,871,684 was the value of the animals, $192,756,608 of the meat and meat products, and $7,104,770 of the dairy products. The total value of the exports of animal products was about $3,000,000 greater than the like exports of the previous year, but there was a decrease of nearly $8,000,000 in the value of cattle exported. This was due to the sharp demand for beef cattle in this country.

Of the 392,884 cattle exported, 295,346 were inspected, tagged, and certified as to health. The others shipped were from ports where inspection is not provided and is made to countries where a Government certificate of inspection is not required. Of sheep, 401,132 were inspected and 212,178 were certified for export; of horses, 19,990 were inspected and 10,975 certified for export. The value of the cattle exported was $29,902,212; of horses $10,048,046; of mules $2,692,298; of sheep $1,940,060.

The inspection of vessels for carrying live stock has been conducted with a view to the best possible service and the most humane treatment of the animals. The percentage of loss in ocean transit of cattle is now reduced to 0.13 for cattle, 0.89 for sheep, and 0.65 for horses.

The number of clearances of vessels carrying live stock was 837, which was considerably less than for the previous year—a condition due to the decreased exports of cattle and horses.

Inspection Service for Import Animals.

There were inspected and admitted from Mexico 65,213 cattle, 3,776 sheep and lambs, and 2,090 goats; also a few asses, horses, mules, and hogs. Through ports on the seacoast, horses not subject to quarantine were imported to the number of 2,283.

One of the most important duties of the Bureau of Animal Industry is to maintain strict quarantine at the ports of the seacoast in order to prevent the introduction of animal plagues. The efficiency of this service has been shown in the past, and it is a service by which the live-stock interests of our country are directly conserved. The live-stock growers demand and receive the most rigid inspection at these ports, for it would be no difficult matter to permit the introduction of

diseases which might easily cost the live-stock growers many millions in direct losses, and at the same time the Government would be under heavy expense in efforts toward their eradication.

We imported from Canada 27,716 cattle, 148,313 sheep, 3,305 horses, and 5,356 hogs which were not subject to quarantine. There were also imported and quarantined 1,214 cattle, 231 sheep, and 33 hogs. Besides these there were quarantined animals of various species which were destined for menageries and zoological parks.

For the purpose of preventing the importation of cattle affected with tuberculosis a veterinarian has been stationed in Great Britain, whose duty it is to test with tuberculin all cattle over six months old which are destined for export to the United States. During the year 1,067 cattle have been so tested, of which 928 were passed and 139 rejected. These cattle were representatives of nine different breeds, those predominating being Hereford, Jersey, and Shorthorn.

Exports of Dairy Products.

Experimental exports of dairy products have been made to Japan, China, Cuba, and Porto Rico. This method of making known the better grades of these products has resulted in somewhat increased sales by merchants in San Francisco and New York and some parties elsewhere; but inadequate and unsuitable transportation facilities, the destructive climates of some of the markets referred to, and other unfavorable conditions prevent any rapid increase in this trade. The results indicate, however, that the markets of Japan may be further cultivated.

Under act of Congress of March 2, 1902, the dairy division of the Bureau inaugurated a system of inspection of dairy products offered for export, affixing stamps to the same, and certifying to the character and quality of the articles. Domestic prices, however, have been so high as to prevent any considerable export of high-grade goods other than condensed milk and cream.

Contagious Diseases.

The work of this Bureau with reference to contagious diseases of animals, which has been prominent from the time of its organization, has been continued. This work at present includes the control of Texas fever, blackleg, sheep scab, and maladie du coït, while scientific investigations are in progress to determine the nature and best methods of treating other important diseases, such as tuberculosis, hog cholera, and anthrax. The records show that 1,688,565 doses of blackleg vaccine were distributed during the year, and the reports of its use reduce the loss of cattle after using it to 0.51 per cent of those vaccinated. If we should eliminate from these reports those cattle which were presumably infected before vaccination, and also those which probably died because a mistake was made in the operation, the percentage of loss would be reduced to 0.44. These results indicate that the use of this vaccine has saved to the stock raisers many thousands of head of cattle and consequently a very large sum of money.

BUREAU OF PLANT INDUSTRY.

In accordance with the recommendations in my last report, Congress brought within the scope of this Bureau four additional lines of plant work, viz, the Arlington Experimental Farm, the investigations in the production of domestic tea, the work on foreign seed and plant intro-

duction, and the Congressional seed distribution. It has necessarily required much time to perfect this reorganization, but everything in this direction is now practically complete and the nine main branches of the Bureau are being so conducted as to bring forth the very best work. Much of the success of any work in the Department depends, in the first place, upon good men, and, in the second place, upon giving such men responsibilities of a nature that will develop their best efforts. This policy is followed in the Bureau of Plant Industry, and as a result there is an earnest corps of workers, each knowing his duty and performing it with all the energy at his command. Owing to the fact that much of the detailed work connected with the reorganization was completed last year, it has been found practicable the present year to devote considerable attention to the development of new fields, a few of which may be briefly referred to here.

The nature of the work of this Bureau is such that cooperation with the State experiment stations is an important factor, and for this reason very close relationships have been established with station investigators in about thirty States. The work undertaken conjointly with these stations is of the most varied character.

Farm Management.

As the work of reorganizing this Bureau developed, the need was felt for properly coordinating all the varied lines of plant work in such a way that they could be brought directly home to the practical farmer and fruit grower in all parts of the country. To this end, I have approved the establishment within the Bureau of an office of Farm Management, which shall have for its object the bringing together in concrete form of all the facts developed in the Bureau as a whole, sifting the results, and applying them in a practical way where they will do the most good. To enhance the value of this work general studies have been inaugurated in the matter of securing facts regarding the way in which the best paying farms in the country are being managed, and what are the relationships of surrounding conditions, such as proximity to markets, ways of leasing or controlling the lands, soils, and climate, and the methods of farming followed. With the knowledge thus secured it will be practicable to lay out a working plan for a particular farm in a particular region, the object being in all cases to have such plans serve as object lessons for type regions rather than for individuals. In line with this plan there is now being undertaken in different parts of the South demonstration experiments for the purpose of showing the possibilities of more diversified farming.

With the cooperation of farmers, working plans are being devised whereby the present system of growing only one crop will be changed so as to secure more diversification, thus insuring greater profits and the building up of the fertility of the land. There are many thousands of acres in the South where the same system of farming has been carried on for years and where it would be a great advantage to inaugurate changes which would lead to the building up of the fertility of the soil and give broader opportunities to those handling the same. As a specific example of this work there is now being developed in the South, as object lessons, a system of what will be called "one-man" farms. These are small areas of land in the pine woods region upon which a system of farming is being developed of such a nature as to appeal directly to the class of farmers who must necessarily handle such land. Instead of a single crop, simple systems of rotation

are being put into operation, and the question of the proper stock to keep is being considered, all being of such a nature that the work can be handled by one individual. In other regions, where the conditions are different, more elaborate plans are under way whereby considerable tracts of land which have for years been cropped to cotton are being arranged for a regular rotation, introducing stock as an element for the purpose of showing the possibilities of such diversification and its bearing on the welfare of the different communities.

Extension of Fruit Markets Abroad.

With the increasing production of special crops there is felt the urgent need for broader markets. This is particularly the case with perishable products, such as fruits and certain kinds of vegetables. There have lately been undertaken, in a limited way, some investigations having for their purpose the extension of the export trade and the improvement of the methods of handling these products for foreign and domestic use. Several experimental shipments have included summer apples, peaches, fall pears, and sweet potatoes—products in which an export trade is undeveloped; and winter apples, in which there is a large and increasing trade, but in which it is desirable to bring about improvements in the methods of handling and shipping.

The results so far obtained indicate that the first-named products may be landed in European markets in good condition if proper care is exercised in all of the operations from the orchard or field to the final destinations. A net return has been realized equal to, and in most cases in excess of, domestic values. It is shown also that the net return for a given fruit is largely influenced by the kind of package in which it is forwarded, and by the methods of packing and shipping it.

These preliminary investigations have already encouraged growers to ship some of these fruits in a commercial way and to adopt the suggestions brought out by the Department investigations. The fruit export trade needs careful investigation, both at home and abroad, in order that the methods of the American fruit grower may conform more closely to the foreign practices of handling and distributing our fruits and to the requirements of the foreign consumer.

I wish here to point out the necessity in work of this kind for a thorough and systematic study of the different foreign markets, in order that the American farmer and fruit grower may act intelligently in making shipments. To this end a plan is being devised whereby an experienced man will be sent to one or more of our most promising foreign markets to study all the prevailing conditions, and to secure and handle experimental shipments of fruits and vegetables, noting the condition in which various shipments arrive, the methods of packing which give the most satisfactory results, and looking after numerous other details which can be determined in no other way. Such an agent would also be in a position to secure valuable facts regarding the products with which we are compelled to compete, and would be able to point out methods by means of which we could best meet this competition.

To make this work still more valuable, the Department's agent or agents could do much toward enlightening the general public in such foreign countries in regard to the value of our products for general consumption. There is no reason why many of our fruits and vegetables can not be sent abroad and sold at a price that would place them

within the reach of the average consumer, provided he was aware that he could obtain them, and knew something of their value as food. In other words, it seems that the time has come for decisive action in the matter of exploiting abroad such products as have been mentioned; and to accomplish this with the best results trained men, and men of good judgment, will be required. If sufficient funds are available, it is planned to inaugurate this work the forthcoming year in a limited way.

Plant Physiology and Pathology.

The practical utility of thorough scientific investigation of agricultural problems is nowhere better demonstrated than in the Department's work in the broad field of physiology and pathology. While the greatest scientific accuracy is demanded on the one hand in the study of the normal and abnormal or diseased condition of plants, on the other hand no effort is spared to make the knowledge thus obtained of practical use. Following are some of the results of the work of the past year.

PLANT DISEASES.

PEAR BLIGHT.

This disease, also known as fire blight or apple blight, is the cause of heavy losses annually. It has been especially severe for the past two years in the Southern and Pacific Coast States. The Department several years ago discovered improved methods of treating this disease, and during the past year a large field demonstration of the method was made in Texas in a place where the disease was so severe as to thoroughly test the treatment. This experiment, on a commercial scale, was entirely successful. Four to five thousand bushels of fruit were saved in the treated orchard, while in the untreated adjacent orchard the fruit was destroyed by the disease and the trees greatly injured. Similar demonstrations will be carried out next year in other parts of the United States.

LITTLE PEACH.

Some important discoveries were made during the year in regard to this rapidly spreading disease. In some respects it appears to be almost as serious a trouble as the dreaded peach yellows, and, as in the case of that disease, the Department recommends immediate destruction of the diseased trees. If this is promptly done the disease may be largely stamped out. No resistant stocks have yet been found, though careful search is being made for them.

BITTER ROT OF APPLES.

This disease is one of the worst with which the apple grower has to contend. For the past three years it has destroyed millions of dollars worth of fruit on the trees and millions of dollars worth in the hands of commission men. The method of treating this disease has, in the past, been only partially successful. An agent of the Department has lately discovered that the infection spreads from diseased canker spots on the limbs to the fruit. This discovery will enable us to much more thoroughly control the disease, if not to prevent it entirely. The spraying experiments this year have also been very successful.

BACTERIAL DISEASE OF ENGLISH WALNUTS.

One of the most important industries of southern California is the growing of English walnuts. For several years a disease has been

gaining headway in the orchards and has caused great loss. The Department's experts on the Pacific coast have been studying the trouble and have been especially successful during the past year in improving the methods of combating it. While much still remains to be accomplished, a treatment has been found which will greatly reduce the injury done by the disease.

DECAY OF FOREST AND CONSTRUCTION TIMBER.

Rapid progress has been made during the year in the study conjointly with the Bureau of Forestry of the diseases of forest trees. Special attention has been given to the diseases in the great forest reservations, and practical methods of controlling some of them have been devised.

Recently a serious heart-rot disease of catalpa has appeared in some of the western catalpa plantations. A Department expert has studied this rot fungus, found out what it is, and has devised a method to protect the trees against it in the future. The importance of this is apparent. The planting of catalpa groves is increasing in several of the Western States. The wood is very durable, making good fence posts, telegraph poles, etc.

One of the most important subjects connected with the utilization of forests is increasing the durability of wood when used for construction. A careful study of the various methods of preserving wood was begun the past year by Department experts and much valuable information obtained. The organisms causing decay of fence posts, sills of buildings, railroad ties, telegraph poles, bridge timbers, greenhouse benches, etc., practically all belong to the group of fungi. The Department believes that cheap and effective methods of treating lumber so as to prevent this decay can be found, and considerable progress was made in this direction the past year.

PLANT BREEDING WORK.

DISEASE-RESISTANT CROPS.

The most practical way to fight disease is to use nature's method and get disease-resistant or immune plants. Striking success has been achieved by the Department experts in this line. The development of cotton resistant to wilt disease is now an assured fact and has been taken hold of by the planters on a large scale. Large tracts of land in the Sea Island district of South Carolina which had been abandoned on account of this disease were planted the past year successfully with resistant strains of cotton, and good crops secured. The discovery during the past year of a variety of cowpea—"Little Iron"—resistant to "wilt" and "root-knot" (two of the worst diseases of this important crop in the South) is a matter of great importance to Southern agriculture, where the need of leguminous crops for forage and soil improvement is especially felt. Thirty bushels of seed of this resistant variety were distributed during the past year.

Satisfactory progress was made during the year in securing varieties of cotton resistant to the Texas root-rot, and some evidence was obtained that varieties may be developed resistant to the dreaded cotton boll weevil.

BETTER UPLAND COTTONS.

One of the greatest needs in improving the cotton industry of the United States has been to secure a long-staple Upland variety which is of good quality and productive.

The long-staple Upland varieties at present existing are all of them rather light producers, and are defective in that the fiber is borne on fuzzy or tufted seed, which makes them difficult to gin.

The aim of the Department's experts has been to secure productive varieties with large bolls, easy to pick, with fine, strong lint from 1¼ to 1¾ inches long, borne on a smooth black seed. Many hybrids were made with this in view and the result has been successful beyond our expectations. Several varieties of the ideal type desired have been produced, having larger bolls, very productive, with long, fine fiber, borne on smooth black seeds. The experiments of the past year show quite conclusively that these varieties can be made permanent.

Egypt and South Africa are waking up to their possibilities in cotton production, and they are already endeavoring to get some of our experts to help them to develop the industry in competition with the United States. The only way we can continue to maintain our supremacy in the future is to develop and grow better and more productive varieties than will be grown by our competitors.

HARDY ORANGES.

The work of developing frost-resistant oranges was started several years ago, and the progress of the work has been reported from time to time. During the past season we have obtained the first fruits of these hybrids. These are intermediate in character between the Florida sweet orange and the hardy trifoliate, and have good, though few, seeds. There is therefore strong probability that from the seeds of these fruits we shall obtain numerous varieties with the qualities desired.

WHEAT BREEDING.

Several of the Russian winter wheats are superior to the American varieties; still there is room for improving on the Russian varieties. As a rule Japanese varieties are early maturing, while the better Russian sorts are late. Hybrids between the Japanese and Russian varieties have already been obtained having the good qualities of the hardy Russian sorts and the early ripening quality of the Japanese. Early varieties often escape the worst periods of drought and are less likely to be injured by rusts and other fungous and insect pests. Gratifying progress has also been made during the year in breeding rust-resistant varieties and nonshattering sorts.

NITROGEN-GATHERING BACTERIA.

Attention was called in my last report to the importance of nitrogen in the nutrition of plants, and the discovery of a new method of cultivating the bacteria which gather nitrogen in connection with leguminous crops was announced. This method has been perfected during the past year. The reason for the failure of former work in this line, both in this country and Europe, has been determined, and a new, simple, cheap, and thoroughly satisfactory method of growing and distributing the tubercle bacteria for all the important leguminous crops has been perfected. The nitrogen-gathering power of the bacteria grown by our new method is at least five times as great as the nitrogen-gathering power of the ordinary forms found in nature, and the new forms, instead of being restricted to certain legumes, have a much wider range of activity. Field tests on a large scale were started during the year, and advance reports from the cooperating farmers show extremely favorable returns from the use of these organisms.

Botanical Investigations and Experiments.

During the year the botanical investigations of this Bureau were pushed forward with vigor. Some of the more important results accomplished in this field are outlined below:

THE COMMERCIAL GRADING OF GRAIN.

A movement to secure an improvement in methods of inspection and toward greater uniformity in work of inspection departments of the large grain markets is now well begun, as a result of an organization of the chief inspectors of these markets. The interest manifested in this movement by all branches of the grain trade gives reason for believing that there may result from it a system of inspection and grading, maintained by the trade organizations, which shall be honest, efficient, and uniform throughout the country, and which shall insure to the farmer a premium for high quality of product, and to the consumer the quality of grain he demands and pays for. The Department is aiding this movement as much as possible by cooperating with these chief inspectors in working out simple and practicable methods for determining and accurately stating the quality of grain and studying causes and methods of prevention of deterioration of grain in storage and in transit.

AMERICAN AND EUROPEAN RED CLOVER SEED.

The study of the merits of red clover of American as compared with that of European origin has been continued, with the cooperation of a number of agricultural experiment stations in the clover-growing States. From the 1901 plantings the results were practically the same as those of the year before in the testing garden at Washington. The European clovers were not able to stand the hot and dry periods of our summer, but suffered badly from sun scald, and were generally of a much lighter color and less thrifty than those from our own seed. The same facts hold true for the plantings made this year, and it is evident that the European clover, unless it be some from the extreme north, is not adapted to the clover-growing sections of the United States.

NEW REMEDY FOR SHEEP POISONING ON THE STOCK RANGES.

The great stock ranges of the Northwest contain approximately one-third of the sheep in the United States, representing a value of more than $40,000,000. The owners of these sheep suffer an annual loss conservatively estimated at 1 per cent, or $400,000, from poisonous plants. During the past year the Department has continued its investigation of this loss and has succeeded in isolating poisonous principles from the species of camas and from one of the lupines, the two kinds of plants which, next to the loco weeds, cause the greatest percentage of loss in the Northwest. The antidote for poison camas announced by the Department in 1900, viz, drenching with a 1 per cent solution of permanganate of potash and sulphate of aluminum, while effective, can be successfully applied by one man to only a few sheep. Some remedy was demanded which could be more quickly applied when a large number of sheep are poisoned. Our physiological tests of the active principle of poison camas on rabbits and other small animals, subsequently verified with sheep, showed that considerable quantities of the poison passed from the system in the

urine. A series of tests was then instituted with drugs that are known to stimulate the action of the kidneys. It has now been demonstrated that a combination of diuretin and caffeine is a satisfactory antidote for this poison; and as it can be given very rapidly by means of a hypodermic syringe, one man can apply the remedy to several hundred sheep in a few hours.

AN IMPORTANT STEP IN HEMP CULTURE.

More than nine-tenths of the hemp produced in the United States is grown in Kentucky, and at present prices it is regarded as second only to tobacco in profit as a farm crop. It yields a good profit there, notwithstanding the fact that practically no labor-saving machinery or improved methods of handling the crop have been introduced. The hemp is nearly all cut by hand, and after much laborious handling in the process of curing and retting it is broken on a hand brake. In Nebraska, where the industry is being established, a new and important step has been taken in cutting the crop with an ordinary mowing machine. A simple attachment, which bends the stalks over in the direction in which the machine is going, facilitates the cutting. The work is regarded as not much more difficult than that of cutting clover or alfalfa, and one man with a span of ordinary farm horses and a mowing machine that has a 5-foot or a 6-foot cutting bar will mow about 10 acres per day. The cost of cutting hemp in this manner is 50 cents per acre, as compared with $3 to $4 per acre, the rates paid for cutting by hand in Kentucky.

The hemp, after being mowed, is left where it falls until retted, except where it is especially heavy. In that case it is necessary to turn it to secure uniformity in curing and retting. It is then raked up and taken to the mill, where the fiber is extracted by means of a series of fluted rollers and beaters. By these methods hemp tow is produced nearly equal in value to Kentucky rough hemp, and at a total cost, exclusive of rent of land, of about $20 instead of $45 per ton.

THE UTILIZATION OF FLAX STRAW.

Efforts are being made to utilize the fiber contained in the thousands of tons of flax straw produced from the flax raised for seed in the Dakotas and Minnesota. Heretofore most of this straw has been burned to get it out of the way. Now large quantities, after being cut and thrashed in the ordinary manner, are subjected to a breaking process which produces a fiber of excellent quality for paper pulp and also a fair grade of fiber for textile purposes. During the past season satisfactory results have been obtained in the use of North Dakota flax for the manufacture of binding twine.

DEVELOPMENT OF THE SISAL INDUSTRY.

The demand for sisal for the manufacture of binding twine is rapidly increasing, owing largely to the advent of the corn binder. The sisal plant is very exacting in regard to the conditions under which it may be cultivated successfully, and, as the areas having the proper conditions for its growth are comparatively limited, it is of the utmost importance to our American consumers of binding twine, as well as to the fiber producers in our tropical territories, that land suitable for the growth of the sisal plant be utilized so far as possible. These facts have been accentuated by the high prices paid for sisal fiber during the past year. A brief investigation has been made of the sisal industry

in the Bahamas, where the conditions are somewhat similar to those in Porto Rico. Some sisal plants from the Bahamas have been sent for trial to the Porto Rico experiment station at Mayaguez. There seems to be little doubt that the sisal plant can be successfully cultivated in limited areas in Porto Rico, as it is now being cultivated in Santo Domingo. It has been introduced into Hawaii, and the first commercial crop has been harvested there during the past season, the fiber produced finding a ready market at good prices in San Francisco.

THE MANGO AND ALLIGATOR PEAR IN PORTO RICO.

Reports are in preparation advising the extensive planting of superior varieties of mangoes and alligator pears in Porto Rico, to supply the increasing demands of the markets of our Eastern cities. That these fruits are not already as popular in the United States as bananas and oranges is due to the fact that there has been no adequate or regular supply of good quality. Porto Rico offers natural conditions very favorable for their culture, and improved facilities of transportation have simplified the commercial problem. Varieties much superior to those now grown for home use in Porto Rico have been found by representatives of the Department in Guatemala and Mexico.

CULTURE OF THE CENTRAL AMERICAN RUBBER TREE (CASTILLOA).

It is generally supposed that a continuously humid climate is necessary for rubber culture, but in southern Mexico it is obvious that an alternation of distinct wet and dry seasons is favorable to the production of rubber by Castilloa, which will permit a much wider use of this tree in our tropical islands than has appeared possible hitherto. The failure of some of the earlier experiments may be ascribed to planting in situations too uniformly moist. The tree will often grow luxuriantly where it will produce little or no rubber, as many planters have learned to their cost. Rubber is the most important vegetable raw material now imported for manufacture in the United States. The agricultural production of rubber is assured, and several millions of capital from the United States have been invested already in Mexican rubber plantations. The extent, however, to which these and similar enterprises in other countries can be made profitable depends on the solution of many new agricultural problems.

COFFEE SHADE.

The coffee industry of Porto Rico has been injured by the presence of too many shade trees in the plantations, owing to the belief of the planters that heavy shading is necessary. A study of the flourishing coffee industry of Guatemala establishes the facts that coffee of the highest grade can be grown entirely without shade, and that the diminution of shade lessens the ravages of the Central American leaf disease. The general opinion that the foliage and fruit of the coffee shrub are benefited by shade is erroneous, but the shading of the ground is often a cultural advantage. The nitrogen-collecting powers of leguminous shade trees have also contributed largely to the good effects commonly ascribed to shade, so that the selection of the best leguminous shade trees and soiling crops is of much importance to the coffee planter.

POMOLOGICAL INVESTIGATIONS.

Fruit growing is the dominant type of agriculture in many parts of the country. Formerly it was an incidental feature of farm manage-

ment. Now enough of certain kinds are grown for domestic use, and a large export trade has been developed. America grows fruit on an extensive scale in contrast with the small, garden-like areas of Europe. In America fruit is a common article of diet; in European countries it is a luxury. Europeans are beginning to know and value American fruits, but the principal consuming population of Europe is yet unacquainted with them. There are great possibilities in the export trade.

Domestic practices in culture and in methods of handling and marketing fruits are in need of improvement. Greater knowledge concerning the adaptability and distribution of varieties is urgent, and knowledge concerning the adaptability of European fruits to American conditions is desirable. Along these lines the pomological investigations of the Department have been largely proceeding since my last report, and in the office the great mass of scattered information on pomological matters and pomological collections is being systematized for practical use.

THE COLD STORAGE OF FRUITS.

Cold storage, or refrigeration, is a necessary adjunct to the rapidly developing fruit interests of the country. There is little known about the influences which govern the keeping qualities of fruits and vegetables. The Department is investigating this subject, and has strong support from fruit growers, fruit handlers, and warehousemen. The Bureau of Chemistry is cooperating with the Pomological Investigations in studying the chemistry of fruit-ripening processes. The investigation will require several years to secure general conclusions, but already important commercial results have been obtained.

"Scald," or a skin discoloration, is one of the serious storage difficulties with many apples. The cause is yet undetermined, but the investigations indicate that the susceptibility can be largely reduced by allowing the apples to become more highly colored or more mature than usual before picking. Such fruit also keeps equally well in storage. Pears and peaches, though usually stored with difficulty in a temperature of 36°, keep much better in a temperature not above 32°.

Fruit, like Bartlett pears and peaches, that ripens quickly after picking, and which is stored for a short time only, keeps best in open packages in which there is a free circulation of air which quickly reduces the temperature of the fruit; but winter apples, to be held for a long period, keep best in a closed package, which prevents evaporation from the fruit. The Department is investigating the influence of cultural conditions, methods of transportation, and systems of refrigeration, and the results seem likely to clear up many of the present cold-storage difficulties.

VITICULTURAL INVESTIGATIONS.

The viticultural investigations of the Department relate largely to the introduction of European table grapes into the Southern States, to various problems connected with the propagation of European and native grapes, and to the manufactured products of the grape.

In the experimental vineyard of European varieties at Earlton, Fla., established in 1899, several varieties are very promising and seem worthy of commercial planting in a restricted way. In this vineyard, which is on sandy soil, the distinct superiority of stocks of the Rupestris type over Riparia stocks has been demonstrated for the Vinifera varieties.

In North Carolina the experimental vineyard of similar varieties shows several promising varieties, though the results are less encouraging than in Florida.

An extensive experiment in bench and field grafting of Vinifera grapes has been begun to determine the relative congeniality of different varieties to different resistant stocks and the behavior of the grafted vines on various kinds of soils. This work is planned to have distinct bearing on the grape industry of the South and of the Pacific coast.

An investigation of the influence of dipping grape cuttings in water at different temperatures and for varying lengths of time upon their growth, and to destroy the Phylloxera, has demonstrated that the limit of safety was reached in a temperature of 50° C. with a five-minute immersion.

Investigations are also in progress relating to stocks that are resistant to the Phylloxera, and which are adapted to the grape growing of the Pacific coast.

The Department is also making a careful study of the methods of manufacturing unfermented grape juice and of its importance as a commercial product.

FRUIT DISTRICT SURVEY.

The adaptability of varieties to the conditions under which they are grown is a matter of fundamental importance, and no question is more often asked by a prospective fruit grower than "What varieties shall I plant?" The object of this survey is to determine the varieties of the different fruits best suited to the conditions where they are to be grown and to study the influence of conditions upon the behavior of varieties.

The funds available for this work have made it possible only to survey some of the more important sections of the Piedmont region of Virginia, the Blue Ridge section of Maryland, and a portion of a similar area as it extends into Pennsylvania. Much important data regarding the behavior of the numerous varieties of fruits already grown there have been accumulated. This survey is being extended to other fruit-growing sections as rapidly as possible.

In connection with this work an extensive cooperative system of phenological observations has been established. It is expected that these observations, extended over a period of several years, will throw light on several perplexing questions regarding the behavior of varieties and their adaptability to the various fruit-growing regions.

SPECIAL PROBLEMS IN POMOLOGY.

Investigations are well under way with pomological problems connected with the pecan industry, the peach industry, and the citron of commerce industry of the Pacific coast. On all these lines there is a large demand for reliable information, and the Department is preparing to issue publications covering them.

Grass and Forage Plant Investigations.

The value of the hay crop in this country exceeds that of any other crop except corn. When we add the yield of pasture lands to that of hay fields, the total exceeds the value of even the corn crop. Investi-

gations of grasses and forage crops are therefore of vital importance to American agriculture. The investigations in this line during the past year have shown that the maintenance of soil fertility is intimately associated with the production of forage crops and their proper utilization on the farm. Those States which are noted for the production of such crops not only have maintained the original fertility of the soil, but they spend for commercial fertilizers less than 1 per cent of the annual value of their crops, while those States which pay least attention to forage crops have impoverished the soil and spend annually for fertilizers from 5 to 9 per cent of the total value of their crops.

LEGUMINOUS FORAGE CROPS.

The influence of leguminous forage crops in restoring fertility to the soil is well known. No system of agriculture can be indefinitely maintained without some crops of this character. From the earliest times clover has been the foundation of agriculture in our Northern States. But with each succeeding year the difficulty of securing a stand for this important crop increases, and there is a pressing demand for a suitable substitute for clover. The Department has undertaken to meet this demand by the introduction of alfalfa in the clover region. The success which has thus far attended our efforts in this direction is most encouraging. It has been demonstrated that alfalfa can be successfully grown in nearly all the Northern States. This work promises so much that we desire to push it vigorously during the coming year.

In our Southern States the cowpea is deservedly popular as a leguminous crop, both on account of its feeding value and its beneficial effect on the soil. But on account of its habit of growth this plant is difficult to harvest, either for hay or for seed. The Department has collected all known varieties of cowpeas in order to study the characteristics of each. We have undertaken to produce varieties that shall be free from the objectionable characteristics of those now grown, and have reason to hope for complete success. Other leguminous forage crops are being tested, both at Arlington Farm and at various places in the several States. Among these is a new and promising variety of alfalfa from South America that resists the rust which frequently attacks the common form, and which grows taller than the latter. As soon as seed of this variety can be obtained in quantity it will be distributed in those sections where there is most need of it.

GRASS GARDENS.

The grass garden on the Department grounds has been improved in a number of ways, and contains a large number of valuable grasses, legumes, etc. During the year this garden has been visited by a large number of people interested in agriculture, who have thus had an opportunity of observing many forage plants new to them. The public has shown a lively interest in this valuable display, which includes several valuable lawn grasses and ornamentals. An extensive grass garden was also maintained by this Department on the grounds of the Exposition at Charleston, S. C., and the correspondence received from Southern farmers relating to this garden shows that it was considered one of the most valuable features of our exhibit. It has been the means of introducing several new forage plants in the Southern States.

RANGE IMPROVEMENT.

The investigations in this branch of work have shown that the depleted Western ranges may be brought back to their original productiveness by proper methods of range management. Heretofore this work has been confined to small experimental areas. We have now progressed to the point where it becomes necessary to cooperate with stockmen in the actual management of selected areas of range lands. To do this it is necessary that we control the grazing of stock on such areas. To this end I repeat my former recommendation, namely, that action be taken by Congress giving you, Mr. President, authority to secure for the experimental needs of this Department such tracts of public range lands as may be necessary for the best interests of the work.

SOIL AND SAND BINDERS.

Along the Atlantic and Pacific coasts and the shores of the Great Lakes, as well as in many inland places, there are to be found extensive areas of drifting sand. These shifting dunes of sand frequently destroy farms, cover up farm buildings, and interfere with the operation of railroads. The Department is engaged in investigations having in view the covering of these sand dunes with vegetation to prevent drifting. Several species of plants have been found that can be propagated rapidly in this drifting sand. Several successful plantations of these have been made, and others are now being made. Some of the leading sand-binding grasses are grown on an artificial sand dune in the grass garden on the Department grounds, forming a very instructive feature of our outdoor exhibit. From the results thus far secured in other countries we have reason to hope that we may finally bring these barren and dangerous sands into useful grass and wood lands.

CROPPING SYSTEM.

This Department is collecting data concerning the systems of farm crops used in various parts of the country, in order to study the relation of such systems to the maintenance of soil fertility. The data already at hand show that in those sections where a one-crop system prevails the soil rapidly loses fertility, and there is a large and increasing demand for commercial fertilizers, while in those sections where a system of rotation of crops prevails, particularly a rotation including forage crops to be fed on the farm, the soil continually improves, and commercial fertilizers are not used except on small areas for special crops. I believe that this Department can do much for agriculture in this country by devising suitable cropping systems for those sections where present systems are unsatisfactory, and giving the farmer information about the best methods of utilizing his crops.

HORTICULTURE.

EXPERIMENTAL GARDENS AND GROUNDS.

As pointed out in my last report, the Experimental Gardens and Grounds under the reorganization have been made exceedingly useful as an aid to other branches of work carried on by the Bureau of Plant Industry and other Bureaus in the Department. With a view to still further increasing the value and efficacy of this work, investigations have been inaugurated having for their object the securing of information on crops which are cultivated more or less intensively in various parts of the United States. Special attention has been given to the cultivation

of plants under glass and the elucidation of problems having a bearing on this important industry. The Experimental Garden is one of the oldest branches of the Department, and since this work was inaugurated a great many valuable plants have been accumulated. These have not been made as available for study as they might be, and for this reason plans have been put in operation whereby the various collections on the grounds and in the greenhouses will be brought together, properly labeled, and made useful for visitors and others who wish to study them.

A special feature of this work will be the development on the grounds of gardens of economic plants. It is planned to bring together a considerable number of the various native plants of the Eastern United States for the purpose of showing the possibilities of utilizing these plants in the simple decoration of the home and of schools. It is also planned to develop various collections of economic plants, such as drug and medicinal plants, and plants used in the arts and for numerous other purposes. As a further line of work for this branch of the Department, plans have been put in operation for securing and distributing seedling trees which have more or less historic interest. There are many historic trees in the vicinity of Washington and in the country at large, and it is believed that much good can be done toward arousing an interest in tree planting by distributing a limited number of these trees under proper direction. The seedlings, when grown, will be sent to schools in various parts of the country, and there will accompany each tree a concise statement setting forth the historic events connected with the tree itself and the growing of the seedling. The primary object is to keep alive patriotism and to encourage a love for nature and a love for home and the habit of tree planting.

THE ARLINGTON FARM.

The work on the Arlington Farm during the past year has been greatly increased. A considerable portion of the land has been drained, and during the year a thorough survey was made and the ground was platted, so that it was found practicable to begin the real work of experimentation. This farm, previous to its acquisition by the Department, was used for many years as a grazing area for horses and mules not in service, belonging to the War Department. In general it was fairly well covered with blue-grass sod, but many shrubs and trees had grown up to interfere with cultivation. The trees and shrubs were removed, the sod plowed and put into condition for the reception of cowpeas or buckwheat, according to the condition of the area, and the work was completed. About 40 acres of the land which in 1901 were planted in cowpeas were this year devoted to plat work. The plats are uniformly one-twentieth of an acre in area. Some 4 acres of such plats are devoted to nursery purposes, including seedling forest trees, while the rest is given over to experiments with vegetables, plant-breeding experiments, experiments conducted by the Pathologist and Physiologist, Pomologist, etc. In surveying and platting the land the location of barns and future buildings was determined upon, and a barn suitable for important needs is being constructed at the present time. With the facilities at hand it will be practicable next season to inaugurate quite extensive work.

TEA GROWING IN THE UNITED STATES.

The work on the growing of American tea was continued during the year at Pinehurst, Summerville, S. C., in cooperation with Dr. Charles

U. Shepard. Dr. Shepard now has at his place about 100 acres in tea gardens, and his factory is well equipped for carrying on work on a commercial scale and for accurate scientific experiments. With a view to bringing about a clear understanding as to the relationship of the Department to this work, a proper form of agreement has been prepared and entered into by the Department on the one hand and Dr. Shepard on the other. By the terms of this agreement the Department is able to secure the use of the extensive plant of Dr. Shepard for experimental purposes, and will profit by the results from the extensive work that he is carrying on. During the year careful attention has been given to methods of reducing the cost of the production of tea with very satisfactory results. Improved factory methods have also been put into operation, with the result that better grades of tea are now being turned out than ever before. To aid in this work, Dr. Shepard has secured during the year the assistance of an expert tea taster in New York, who has sampled his various grades and thus made it practicable to determine not only the kinds of teas which have proved of the highest quality, but the effects of different methods of picking and handling.

As pointed out in my last report, the yield of tea in Dr. Shepard's gardens last year was about 4,500 pounds, and this year there will be about 9,000 pounds of marketable tea. Some of the gardens have proved very prolific and profitable, while others have given very light yield of tea, having poor quality. All these facts, of course, will enable the Department to profit in further exploiting the work. With a view to increasing the interest in this crop, a tea farm will be established in Texas if suitable land and cooperation can be secured. Agents of the Department are now on the ground looking into the question, and the outlook is very favorable. Whether or not tea growing in this country can be made a commercial success will depend, in large measure, upon most rigid attention to the details connected with the field and factory work. It is not expected that any large profits will be made, but it is believed that by proper and judicious management sufficient profit will result to encourage the planting of the crop in many parts of the South, especially where there is cheap labor available. Proper labor, of course, constitutes one of the most important factors in this matter; but, fortunately, there are many places in the South where hands now idle might be turned to some use in this direction.

Congressional Seed Distribution.

In my last report attention was called to the fact that the distribution of seeds was required by an act very specific in its terms, and that it was my wish to carry out the will of Congress in a way that would result in the most good to the country. During the year rapid advancement has been made in the matter of improving all of this work, and it is gratifying to announce that under the system which is being put into operation little or no friction has resulted. The Congressional distribution for 1901–2 was the largest in the history of the Department, yet notwithstanding this fact all the seed went out on time. With a view to increasing the value of the work, particular attention was given to the distribution of forage-crop seed, cotton seed, tobacco seed, and seed of other special crops. In each case an expert was put in charge of a particular crop and was responsible for securing new, rare, or little known varieties, and the distribution of

each variety in a locality where it seemed likely that benefit would result from its use. Very encouraging reports have been received as a result of this work, especially in the matter of cotton distribution, where a special effort was put forth to secure new varieties or varieties which were known to have value locally, but which had not been generally distributed. With a view to still further increasing the efficiency of the seed work, a number of new plans have been put into operation during the year.

The method of securing seed through a contractor has been abandoned, as it was never satisfactory, offering opportunity for inferior service, and, besides, working a hardship on the seed trade of the country—something the Department has no desire to continue. Under the new system the Department secures its own seed in the open market, and contracts only for the purely mechanical features of the work, such as the packeting of the seed and the mailing of the same. With a view to making this work of more value to the country and encouraging the legitimate seed trade, plans have been inaugurated whereby the Department will gradually substitute new or little-known seeds, such as specialties or novelties, for the more common sorts heretofore distributed. Seedsmen are now cooperating with the Department in furnishing these specialties and novelties, and the Department will distribute them possibly only one year, dropping them then and allowing the demand, if demand there be, to be met by the regular trade. Particular attention will be given in all this work to the distribution of special crops, such as forage, tobacco, cotton, sugar beet, cereals, etc. In the handling of these special seeds and plants the work of the plant-breeding laboratories will be utilized, and the requirements of different sections of the country will receive careful consideration, so that crops will be selected to meet the needs and requirements of the districts into which they may be sent.

Foreign Seed and Plant Introduction.

During the year the Department pushed forward the lines of work on introduction of foreign seeds and plants as rapidly as the means at hand would permit. In carrying on this work the various branches of the Bureau have contributed to the expert knowledge to be applied to the best handling of the crops.

Agents have been sent to the Orient with a view to securing information on crops particularly adapted to the South. Rice has received special attention, and in addition the question of forage crops suitable for this region was also kept constantly in mind. An agent visited India, China, and Japan, and secured many valuable introductions in the way of seeds and plants which will be useful in building up new industries. This work has been greatly aided by the generosity of Hon. Barbour Lathrop, who, at his own expense, has carried on extensive agricultural explorations during the year, assisted by Mr. David G. Fairchild, an agricultural explorer of this Department. Mr. Lathrop has secured and forwarded to this country a number of valuable plants, which are being handled by the Department's agents and by private individuals, to whom such plants have been sent direct by Mr. Lathrop. Particular attention was given to the introduction of the bamboo, which it is believed will prove a promising crop in sections of the West and South, where this plant is hardy.

In former reports attention was called to the efforts of the Department in establishing date growing as an industry in this country. Con-

siderable advance has been made in this direction during the past year, a large shipment of young date trees having been received from Mr. Lathrop. They were planted in the large cooperative date orchard established by the Department in Arizona. This orchard now comprises about 11 acres and contains 580 imported trees, besides 80 native seedlings. Another important introduction during the year through Mr. Lathrop's efforts is the Egyptian or berseem clover, which is very valuable for certain portions of the country as a soil reclaimer and enricher and as a forage plant. The continued fertility of portions of the Nile Valley which are annually overflowed is largely due to the nitrogen-gathering properties of this plant.

Agents have also been sent to Algeria, Egypt, and other parts of Africa for the purpose of studying the irrigated crops of these regions, and also the crops which are particularly adapted to alkali soils. These agents have secured many valuable facts which will aid the Department in its extensive studies of the plants of our own arid and semiarid regions. With a view to securing additional forage crops and cereals from Russia and adjacent countries, an agent was sent to those regions in the early part of the year. The securing of forage crops, particularly the various kinds of Turkestan alfalfa, was the primary object of this visit; although some attention was given to obtaining varieties of fruits and cereals adapted to the dry regions of the Northwest.

MACARONI WHEAT.

The importance of the introduction and establishment of macaroni wheat in the United States, to which attention was directed in my last report, has been amply demonstrated by the results of the past year. We estimate that about 2,000,000 bushels have been harvested this season, but this will not meet the demand for it coming from all quarters. New mills are being built to grind it and old mills have been modified in order to handle it, and it now has its definite grade like other wheats in the Northwestern markets. It yields from one-third to one-half more than the other standard wheats in the same locality throughout the Great Plains region. Furthermore, it extends the wheat area much farther westward over districts of great extent, where it was not considered possible to grow wheat before, owing to light rainfall. The macaroni made from this wheat is pronounced by experts to be equal, if not superior, to the imported product, so that the success of this industry is assured.

WINTER WHEAT INTRODUCTION.

The results of the past year indicate that the winter wheats introduced and tested by the Department are likely to prove of as great, if not greater, value than the macaroni wheats. Four or five varieties obtained from east and south Russia are much more hardy than any varieties now grown in this country, and will extend the winter wheat area several hundred miles north and some distance farther west than at present. This means an increase of 5 to 10 bushels per acre over the standard spring wheats now grown in the same localities.

Quite valuable results have also been secured in the introduction of Swedish oats, proso or broom-corn millet, malakhof, sugar corn, and a number of other Russian crops. There has been rapid advancement during the year in the rice-growing industry, largely through the efforts of the Department in the introduction of new forms and the obtaining of information from abroad bearing on the methods of

handling the crop and preparing it for market. Particular improvement has been made in the rice-growing regions of Texas and Louisiana, where the work of the Department has yielded the most striking results. In former reports attention has been called to the great value of this work to the two States named, and such has been its development that at the present time the rice production in this country about equals the demand.

The Jordan almond is another successful introduction during the year. There are about 5,500,000 pounds of almonds grown in California, but many pounds are still imported from Spain for the reason that the California nut is not equal to the best imported kind, known as the Jordan. During the year buds and scions of this variety have been secured and sent to California, and it is certain that in a few years California-grown Jordan almonds will be on the market.

A special effort was put forth during the year to secure alkali-resistant crops, particularly alfalfas and cottons. Seed of the Turkestan alfalfa has been obtained and is now on the way to this country, and will be distributed, under proper direction, during the year. Seed, also, of a number of alkali-resistant cottons has been obtained in Algeria and Egypt, and steps are being taken to place these seeds where the conditions are such as to make their success a valuable adjunct to certain parts of our Western country.

As a means of further systematizing all of the work connected with the distribution of seeds and plants by the Department, and the introduction of the same from foreign countries, plans are being perfected for establishing in a number of places in the country testing gardens, which will enable the Department to work out a number of important problems connected with these investigations. It has been found by experience that the promiscuous dissemination of seeds, many of which are often of great value, does not give in all cases satisfactory results. It is highly important in all such cases to be able to determine definitely where such plants and seeds are likely to prove most successful. After this is known it is still necessary to convince farmers or fruit growers of the feasibility of growing the particular crop. Even then the work is not finished, for although the crop may be grown readily, the question of a market must be considered.

Suitable testing gardens, conducted possibly in cooperation with some of the experiment stations, but under the direct control of the Department, will be of great value in further continuation of this work. Such gardens may be used for the purpose of standardizing the various varieties of vegetables now being offered by the seedsmen throughout the country. There is at present a great deal of confusion regarding varieties of vegetables, and while the work of breeding is growing apace it will be well worth while to fix the types of varieties and disseminate better strains of standard sorts. If the Department would set a high standard in this matter it would probably result in a great diminution of the indiscriminate renaming of varieties and in the introduction of such as are new only in some slight respect. It is obvious that work of this kind to be of the greatest value must be conducted under very careful conditions and be carried on in a sufficient number of regions to get results which will be of real value.

BUREAU OF FORESTRY.

On July 1, 1901, the Division of Forestry became a bureau. It has therefore completed its first year under the new form of organization.

The results obtained have amply justified the change and the increased appropriation which accompanied it. Interest in forestry and a perception of its possibilities as the means of making productive a great national resource have developed so swiftly in the United States that the discrepancy between the capacity for public service of this branch of the Department of Agriculture and its opportunities was never so great as it is now.

During the past year the Bureau of Forestry has notably increased the store of knowledge on which all forestry depends, and has made large gains in introducing practical management of forests, both of public and private ownership. Its field work has engaged 162 men, and has been carried on in 42 States and Territories.

The forest work of the Department of Agriculture has hitherto proceeded as rapidly as the scanty means of forest education would supply men, and its growth has been normal and safe. In view of the greater product of the forest schools and the immensely growing demand upon its services it might hereafter safely increase its rate of progress. To check the growth of the Bureau of Forestry at this time will likewise check the spread of public sentiment in favor of forest protection. It will dull the desire of forest owners, applicants to the Bureau for assistance, some of whom have already waited for their turn until their patience is almost exhausted. It will dampen the willingness of young men of the right stamp to make forestry their profession, because they look forward with practical unanimity to the Government service. A single frost which would pass over a mature tree without effect will often injure and retard for years the growth of a healthy seedling. I conceive the Bureau of Forestry to be in precisely that situation.

Organization of the Bureau.

The work of the Bureau of Forestry is organized along four lines: Forest management, forest investigation, records, and tree planting.

Forest Management.

The Bureau of Forestry exists to secure the best management of the forests of the United States in the interests of the whole people. This involves not only the development of a science of American forestry, but also the general introduction of conservative methods in handling forests of private ownership.

The Division of Forestry offered in October, 1898, to give advice and assistance to forest owners desirous of introducing conservative management. The response to this offer was immediate, and has grown steadily in volume. During the last fiscal year 37 applications were received, asking advice for the management of nearly 2,000,000 acres of forest lands. Altogether the advice of the Bureau has been asked, since its offer in October, 1898, on 4,709,124 acres.

The working plans of the past year are in the nature of solutions of seven typical and widely differing forest problems. These problems are:

Management of a Southern Appalachian forest, containing a great variety of trees, mainly hardwoods, in a somewhat inaccessible region, where only the most valuable species can be lumbered at a profit and where special measures are necessary to assist their reproduction and to prevent the progressive deterioration of the forest as the best woods are cut out. Fire protection, at a cost which is not prohibitive from a business standpoint, forms one of the important questions involved.

The tract studied has an area of 110,000 acres, and lies in Polk and Monroe counties, Tenn.

Management, in conjunction with coal mining, of a tract of mixed softwoods and hardwoods, containing 50,000 acres, in Scott, Campbell, and Anderson counties, Tenn. Silviculture, contract lumbering, transportation, and protection from fire are the more important points studied.

Management of 60,000 acres in Beaufort and Hampton counties, S. C., on which the most important commercial species is Longleaf Pine. Fire, lumbering, and turpentine orcharding have seriously injured the forest, and the consideration of first importance is a method of treatment which shall restore it to full productiveness while yielding a fair return on the value of the land. The conditions are typical of much of the Southern Pine Belt.

Management of 10,000 acres of fine hardwoods on Grand Island, Michigan, with an accessible market, a high price obtainable for the product, and consequently an exceptionally good opportunity for paying forestry.

Management of 15,000 acres in Herkimer County, N. Y., composed equally of cut-over and virgin forest. The most important timber tree is here, as generally in the Adirondack region, Red Spruce, and the chief object of the working plan was to provide for the reproduction of this species and to suggest such changes in present methods of lumbering as will give immediate and good returns from the forest and at the same time will insure a profitable future yield.

A somewhat similar problem, but in a different locality, was that presented by a tract of 275,000 acres in northwestern Maine. Field work was completed during the year on 150,000 acres of this tract, timbered mainly with Red Spruce and Balsam, of which the former, as commercially the more valuable of the two, should be favored as the source of subsequent crops.

The last tract on which field work was completed during the year was one of 15,000 acres near Arden, N. Y. The forest consists of second-growth hardwood and is for the most part in poor condition. The working plan advises a system of thinnings by which the condition of the forest will be improved and which will at the same time yield good returns in firewood.

The total forest area now under management in accordance with working plans prepared by the Bureau of Forestry is 372,463 acres. Material for a number of new working plans is now being gathered. Especially notable is the plan in preparation for a tract in southeastern Texas which comprises an area of 1,250,000 acres and is the largest private holding of timber land in the United States.

By request of the Secretary of the Interior for advice in the management of the national forest reserves, which now include 60,162,525 acres, the Bureau of Forestry became the official adviser for these reserves in matters of forest policy. The making of working plans for the reserves has continued during the year. Field studies have been carried on in the Prescott, the Priest River, and the Big Horn reserves, and a preliminary examination was made of the San Francisco Mountains Reserve. A similar request from the Secretary of War, made during the last fiscal year, has placed the Bureau in the same relation toward the military wood and timberreservations, eight in number, with an area of 117,468 acres. Of these, that at West

Point, containing 2,000 acres, has been examined, and a working plan for its management will soon be prepared.

In accordance with the request of the Secretary of the Interior, an examination has been made of the forest lands within the Lac Court d'Oreilles, the Bad River, and the Menominee Indian reservations, in Wisconsin, in order to recommend measures for the conservative lumbering of the timber they contain.

Forest Investigation.

The studies of commercial trees made during the past year include White Pine, Red Pine, White Oak, Scarlet Oak, Red Oak, and Aspen, in Michigan; Sugar Pine in California; Balsam in Maine; White Oak and Chestnut Oak in Tennessee, Kentucky, and Missouri; Western Yellow Pine in Arizona, and Lodgepole Pine in Wyoming and Montana. Previous studies of the Longleaf and Loblolly pines, of the Sierra Big Tree of California, and of the Bristle-cone Fir in southern California were completed and reports prepared on Western Hemlock and the Pacific Coast Redwood.

Studies of the growth and possibilities of New England second-growth hardwoods were carried on, and an investigation was begun of the distribution and the conditions necessary to the best development of the trees comprising the eastern Missouri and Arkansas swamp forests.

Studies of the forest and its industrial relations were made in the States of Michigan, Kentucky, Ohio, Texas, New Mexico, Arizona, South Dakota, Wyoming, Montana, California, and Iowa. Some of the questions involved were the present and future timber supply, forest fires, and the relation of the forest to stream flow, irrigation, and grazing.

Descriptive studies were conducted in cooperation with the United States Geological Survey of about 3,000,000 acres of the Sierra Forest Reserve and of the region in the Southern Appalachians, within which it is proposed to establish a national forest reserve.

In cooperation with the Bureau of Chemistry, investigations have been undertaken of native tan extracts and their comparative values in tanning, of Philippine gum products, and of possible additions to the present list of native woods suitable for the production of paper pulp.

A cooperative study of insects which injure the forest was begun with the Division of Entomology.

It is highly gratifying that the efforts which the Bureau has been making to discover a less injurious method of turpentine orcharding than that hitherto employed, and to which I made reference in my last report, have been successful, and that the way is apparently open for the general introduction of an improved method which will be of notable value in maintaining the source of the turpentine industry.

Tests of the durability of treated and untreated construction timber and railroad ties have been continued, in cooperation with the Bureau of Plant Industry. The enthusiastic assistance which has been received from railroad companies has demonstrated their appreciation of this valuable work.

In cooperation with the Bureau of Chemistry, and as the result of a widespread and urgent demand, the Bureau of Forestry has taken up the series of tests to determine the strength of the principal merchantable timbers of the United States, which were discontinued in 1896.

RECORDS.

The enlargement of the Bureau's quarters, which took place during the year, made possible for the first time the proper equipment of a library and the transference thither of the entire collection of forest literature from the Department library. This has given the Bureau a large, easily accessible working and reference library. The photographic collection now numbers over 6,000 prints, and a well-equipped photographic laboratory has been installed.

TREE PLANTING.

The work of the Bureau in tree planting for the last year has been chiefly notable in the conspicuous progress made in extending cooperative planting, in the creation of the first reserves for forest planting on Government lands in a region that is now unproductive of timber, and in the successful initiation of measures to control, by means of planted forests, the shifting sand dunes on both the Atlantic and the Pacific coasts.

In tree planting as in forest management the Bureau has sought, as the only method by which the desired end could be attained on a broad scale, to enlist the interest of the private landowner. Circular No. 22, issued July 8, 1899, offers cooperation in the work of planting forests similar to that previously made for forest management. Up to the close of the last fiscal year 262 applications for assistance had been received, nearly 200,000 acres had been examined, and 224 planting plans, covering about 6,400 acres, had been made. Of these, 51 plans for about 3,400 acres were made during the past fiscal year, and 83,597 acres were examined.

These figures, however, by no means cover the actual accomplishment of the Bureau in introducing forest plantations on private lands. The plans made are for 172 localities, in 29 States and Territories. Not only does the example set by each plantation made affect the whole neighborhood, but there has also been in many cases a public agitation of the question of tree planting, with local meetings addressed by the agents of the Bureau. Extensive planting on other land than that for which plans were made has frequently followed. Plantations of this kind will be of very considerable economic value in many States of the Middle West by furnishing local supplies of firewood, fencing, telegraph poles, and railroad ties, besides providing wind-breaks and other protection.

The success of economic tree planting in many scantily timbered or treeless regions of the Middle West is now assured. This means enhanced prosperity for these regions. A local timber supply is a matter of decided importance to the farmer, who needs cheap fuel and fencing. As a result of the Bureau's work, thriving plantations now exist in the Dakotas, Nebraska, Kansas, and Oklahoma, as well as in the older States of Iowa, Illinois, and Indiana.

In New England particular attention has been given to the possibility of profitably planting cheap land with white pine. The supply of this highly useful timber tree has been greatly diminished in the Eastern States. If it can be brought back as a paying forest tree under management, the benefit will be one in which both the landowner and the timber-consuming public will share. So encouraging has been the outcome of the examination of this question by the Bureau that many owners of denuded lands are restocking them with white pine.

THE PROPOSED APPALACHIAN FOREST RESERVE.

In my report on the Forests and Forest Conditions of the Southern Appalachian Mountain region, which has been printed along with your message to Congress on this subject, of December 19, 1901, I discussed briefly the rapid rate at which the forests on these mountain slopes were being removed, and the extent to which the resulting floods were destroying agricultural lands and other property along the streams rising in that region. In that report I stated that the damages resulting from these floods during the year (1901) "approximated $10,000,000, a sum sufficient to purchase the entire area recommended for the proposed reserve."

Subsequent examinations have shown that during the few months following the date of that report the flood damages on these streams, extending across eight different States, aggregated $8,000,000, making a total of $18,000,000 during the twelve months ending in April, 1902. These examinations also show, as additional results of the deforestation of these mountain slopes, (1) that the water powers along these streams, which have an aggregate annual value of $20,000,000 as a basis for manufacturing enterprises, are being gradually but certainly destroyed through the increasing irregularity in the flow of the streams; (2) that the soils which are being washed down from these mountain slopes are rendering annually less navigable the Ohio, the Tennessee, the Mississippi, and other rivers of these Southeastern States; and (3) that the rate of land erosion on these mountain slopes from which the forest cover has been removed is now as great in a single year as it was during ten centuries while these slopes were covered with primeval forests.

A bill providing for the establishment of the forest reserve recommended in my report is now pending before Congress. With an increased realization of the importance of this measure I reproduce here the concluding paragraph of that report:

> The preservation of the forests, of the streams, and of the agricultural interests here described can be successfully accomplished only by the purchase and creation of a national forest reserve. The States of the southern Appalachian region own little or no land, and their revenues are inadequate to carry out this plan. Federal action is obviously necessary, is fully justified by reasons of public necessity, and may be expected to have most fortunate results.

BUREAU OF SOILS.

The organization and work of the Bureau of Soils has been essentially along the same lines as heretofore, with the addition of an important line of work in the division of soil management. Attention has been given, as heretofore, to the administrative work, the soil survey, the tobacco investigations, drainage investigations, and the laboratories maintained in support of these several lines of field work. The wisdom of Congressional action in converting the Division into a Bureau and increasing the appropriation has been shown in the amount of work done and in the appreciation of this work from various sources. The soil survey, particularly, has been greatly extended, and the division of soil management, although merely started during the year, gives promise of some more important results than have been achieved in soil investigations for some time past. Prof. Franklin H. King, formerly professor of agricultural physics at the University of Wisconsin, has taken charge of this line of field work. He is considered peculiarly fitted for this place, and his appointment has been very generally commended.

During the year Mr. M. L. Floyd, the tobacco expert who had done so much to make successful the tobacco investigations of the Bureau, severed his connection with the Department to become general manager of a tobacco corporation organized to grow the shaded Sumatra tobacco in Connecticut, an industry established by this Department. In his new position Mr. Floyd receives far greater remuneration for his services than the Department could afford to pay, in view of the salaries paid to others by the Government.

The interest in the work of the Bureau of Soils is growing, and the demands for work in different parts of the country are increasing, as evidenced by the liberality of Congress in enlarging the appropriation and by the many requests received for the extension of the different lines of investigations. The Bureau of Soils now has a force of over 100 persons, 75 of whom have had a scientific training. It is believed that the results of the work in showing the conditions and resources of the soils of the country and in giving the people precise and accurate knowledge regarding the possibilities of the soils justifies fully every expenditure that has been made and every recommendation that will be made for the further extension of the work. With the fierce competition for commercial supremacy now operating, every particle of information bearing upon the natural resources of the country which will in any way tend to increase the production of our present crops or to develop new methods or build up new industries is of the utmost value, especially if, as in this case, the people are inspired with sufficient confidence to heed the advice of the Department and to take advantage of its work.

Cooperation with State Institutions.

During the year this Bureau has cooperated, as far as possible, with State institutions, including experiment stations, boards of agriculture, and geological surveys; also with Bureaus and Divisions of this Department, as well as with other Departments of the Government. Such cooperation has been particularly close with the North Carolina department of agriculture and with the Illinois experiment station, both of which institutions have contributed money toward the expenses of the soil survey in their respective States. In other States the cooperation has been just as cordial, but the institutions have not been able to render financial assistance. Their advice has been sought and given wherever possible in arranging for and in the carrying on of the work, and the work has been done, as far as possible, with the ultimate object of being of service to the State institutions in the prosecution of more detailed work. The Utah experiment station has cooperated in the line of drainage investigations and has contributed valuable assistance and advice in the work that has been started at Salt Lake City. The Connecticut experiment station and the Pennsylvania experiment station have continued their cooperation in the tobacco investigations with credit and profit to all of the institutions concerned.

The Bureau of Soils, through its laboratories, its soil survey, and its other lines of investigation, has cooperated with and has helped other Bureaus and Divisions in the Department, and has cooperated with the War Department in furnishing an assistant to organize a soil survey in the Philippine Islands, and in furnishing assistants to inspect the soils of some of the military posts and to advise as to the treatment in the establishment of parade grounds, a matter which is of

considerable importance, involving the expenditure of large sums of money where the natural soils are not suited to the formation of a permanent sod.

Progress and Cost of the Soil Survey.

The area surveyed and mapped during the fiscal year was 14,541 square miles, or 9,306,240 acres, and the area previously reported as having been surveyed was 8,082 square miles, making a total of 22,623 square miles, or 14,478,720 acres. This work was carried on during the year in twenty-five States and Territories and in Porto Rico.

The following table shows the total area surveyed during the fiscal year 1902, together with that previously reported, in each of the thirty States and Territories in which the soil survey work has been carried on. This work has been uniformly done on a scale of 1 inch to the mile, and the maps have been published or are ready for publication. This table does not include any areas in which work of reconnoissance merely has been done, but only areas in which actual soil surveys have been made and soil maps prepared.

Areas surveyed and mapped during fiscal year ended June 30, 1902, and the areas previously reported.

State or Territory.	Work during 1902.	Work previously reported.	Total.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
Arizona	95	400	495	316,800
California	753	1,401	2,154	1,378,560
Colorado	150	.....	150	96,000
Connecticut	.....	245	245	156,800
Georgia	571	.....	571	365,440
Idaho	399	.....	399	255,360
Illinois	1,359	.....	1,359	869,760
Iowa	432	.....	432	276,480
Kansas	461	.....	461	295,040
Kentucky	330	.....	330	211,200
Louisiana	202	.....	202	129,280
Maryland	418	1,762	2,180	1,395,200
Massachusetts	.....	155	155	99,200
Michigan	828	.....	828	529,920
Mississippi	666	.....	666	426,240
Missouri	168	.....	168	107,520
Montana	105	.....	105	67,200
New Jersey	908	.....	908	581,120
New Mexico	.....	100	100	64,000
New York	490	.....	490	313,600
North Carolina	1,625	1,800	3,425	2,192,000
Ohio	500	480	980	627,200
Pennsylvania	519	420	939	600,960
Porto Rico	330	.....	330	211,200
South Carolina	686	.....	686	439,040
Tennessee	547	.....	547	350,080
Texas	495	.....	495	316,800
Utah	.....	768	768	491,520
Virginia	1,354	250	1,604	1,026,560
Washington	150	301	451	288,640
Total	14,541	8,082	22,623	14,478,720

The following table shows the area surveyed and mapped and the cost of the work during the fiscal year ended June 30, 1902:

Areas surveyed and mapped and cost of the field work during fiscal year ended June 30, 1902.[a]

State or Territory.	District.	Area surveyed.	Cost per square mile.	Total cost.
		Sq. miles.	*Dollars.*	*Dollars.*
Arizona	Yuma area	95	4.61	437.95
California	Imperial area	169	3.17	535.73
Do	Salinas Valley	344	3.42	1,176.48
Do	Ventura area	240	3.77	904.80
Colorado	Rockyford area	150	4.73	709.50
Georgia	Cobb County	346	1.44	498.24
Do	Covington area	225	.71	159.75
Idaho	Boise area	399	1.81	722.19
Illinois	Clinton County	494	.88	[b]434.72
Do	St. Clair County	215	1.15	[b]247.25
Do	Tazewell County	650	1.39	[b]903.50
Iowa	Dubuque area	432	.94	406.08
Kansas	Wichita area	461	1.94	894.34
Kentucky	Union County	330	2.20	726.00
Louisiana	Lake Charles area	202	3.71	749.42
Maryland	Harford County	418	1.48	618.64
Michigan	Allegan County	828	1.44	1,192.32
Mississippi	Yazoo area	656	2.24	1,489.96
Missouri	Howell County	168	1.14	191.52
Montana	Billings area	105	4.96	520.80
New Jersey	Salem area	498	1.42	700.06
Do	Trenton area	415	2.23	925.45
New York	Westfield area	260	2.89	751.40
Do	Elmira area	230	2.03	466.90
North Carolina	Alamance County	365	1.32	[c]482.80
Do	Carey area	63	3.11	[c]195.93
Do	Craven area	697	.96	[c]669.12
Do	Hickory area	500	1.01	[c]505.00
Ohio	Columbus area	338	1.34	452.92
Do	Toledo area	162	.95	153.90
Pennsylvania	Lebanon area	[d]519	1.48	768.12
Porto Rico	Arecibo to Ponce	330	5.02	[e]1,655.55
South Carolina	Abbeville area	686	1.01	692.86
Tennessee	Montgomery County	547	1.68	918.96
Texas	Alvin area	280	2.45	686.00
Do	Willis area	215	2.70	580.50
Virginia	Bedford area	[d]382	2.11	806.02
Do	Harrisonburg area	542	1.44	780.48
Do	Prince Edward area	430	1.32	567.60
Washington	Walla Walla area	150	1.82	273.00
		14,541	1.83	26,551.76

[a] This includes the salaries of the men while in the area and their subsistence expenses, but not the cost of transportation to and from the area.
[b] Of these amounts, $624.95 was spent by the Illinois experiment station.
[c] Of these amounts, $914.20 was paid by North Carolina department of agriculture.
[d] The portions of these areas surveyed in the previous fiscal year were given in the last report.
[e] Of this amount, $300 was paid by the Porto Rico experiment station.

RECAPITULATION.

Cost of field work		$26,551.76
Supplies		858.84
Railroad transportation		2,766.28
Preparation of reports		12,870.17
Total cost of soil survey		43,047.05
Paid by State organizations		1,839.15
Paid by Department of Agriculture		41,207.90
Area surveyed	square miles	14,541
Cost of work in field	per square mile	$1.83
Preparation of reports	do	.88
Transportation and supplies	do	.25
Average cost	do	2.96
Average cost to Department of Agriculture	do	2.81

It will be noticed that the cost of the work per square mile varies from 71 cents in the Covington area, Georgia, to $5.02 for the work in Porto Rico. The average cost has been $1.83 per square mile, as against $2 per square mile during the preceding fiscal year. The area covered is over two and one-half times as large, and the work has cost 17 cents per square mile less than last year. The variation in the cost per square mile is due in part to the character of the country, the condition of the roads and of the weather, the complexity of the soils, the presence and character of alkali in the Western areas, and the accuracy of the base maps used. The average cost to the Department of Agriculture of the work complete, including supplies and railroad transportation, the preparation of reports, and the salaries of the men during the three winter months, when the field work has practically to be suspended, has been $2.81 per square mile, as against $3.26 per square mile last year, a saving of 45 cents per square mile. This saving is due not only to the greater efficiency of the field parties by reason of their better training, but also to the longer average length of the field season for each party, which has been accomplished by moving the parties from place to place as the season advances. It has been found possible to keep some of the parties out during the winter in Arizona and southern California, and to shift parties working in the Northern States during the summer months to the Southern States during the fall. In this way the average length of the field season has been something over nine months per party, and it is believed that this can be considerably increased, although it is advisable to have each party spend some time at headquarters, not only for the final revision of their reports and maps, but to get acquainted with the office and laboratory work and to keep in close touch with the objects and purpose of the soil survey.

THE FIELD FORCE.

The organization of the field force has been carried to a very high state of efficiency. Administratively the very greatest of care and attention to details is given, and the low cost per square mile shown in the preceding statements is due in a large measure to the judicious and economical management of the force. The salaries of the soil experts employed by the Bureau are low as compared with those paid in other branches of scientific work. The average expense of a party of two men in the field for subsistence and the hire of a team averages about $120 per month, or $1,080 for the field season of nine months. The parties are equipped with the most modern instruments for the classification and survey of soils, and it has been possible to furnish them with such explicit instructions as to the character of their work, the subjects they are to investigate, and the subjects which are to

be discussed in their report upon the area that they know exactly what is to be done on entering a given area and can proceed with their work with the minimum of time for preliminary investigations or reconnoissances. They are required to report to the central office at least once each week, noting the area surveyed, the new soil types established, and the character of their work, and to send in from time to time sections of their map for criticism and suggestion as the work proceeds. It is required that each party shall complete the map in all details and write up the report in final shape before leaving the area. These reports are then typewritten, and a copy returned to the field party for correction or for additions or changes. The work of each party is thoroughly inspected, so far as this has been possible, in order to correlate the new soil types with those already established, and to confer with the men as to suggestions which can be safely made of new methods of cultivation or of new industries which may be established. As the work of the soil survey assumes greater proportions this inspection work becomes more and more necessary and more valuable, and it is advisable that a regular inspection force should be established for the several districts into which the country may be divided.

The scale upon which the soil maps are published enables tracts as small as 10 acres to be represented, and while there must always be some variation allowed in each type, as it would be confusing to show too much detail on the maps, still, where a type is represented by even a small tract of 8 or 10 acres, it is shown upon the soil map, so that landowners may rely upon an accurate classification of their soils according to the types established.

The reports describe in all necessary detail the characteristics of the soils and their important variations; the history of the settlement and agricultural development of the area; the climate, physiography, and geology; the agricultural methods in use and the agricultural conditions in the area, such as the tenure and size of the farms, the efficiency of labor, the principal products, and transportation and market facilities, together with such special problems as may be encountered, such as hardpan, acidity, irrigation, seepage waters and drainage, alkali, and the reclamation of swamp or worn-out lands or alkali soils, as these all have their bearing upon the commercial use and value of the soils.

RELATION OF THE SOIL SURVEY WORK TO THE EXPERIMENT STATIONS.

With the increasing interest in the soil investigations and the economic value which the results have shown in a number of cases, the experiment stations are taking a lively interest in this work, and it seems proper to mention the true relation which should be established between them and the Department in the further prosecution of the work. It seems advisable that the management of the soil survey should be vested in the Department of Agriculture. This insures continuity in the work and uniform classification of soils; also the benefit of experience in other localities in advising as to the commercial possibilities and value of the introduction of new methods of culture and of new crops and industries. It is advisable that the experiment stations and other State institutions should cooperate in this work to the extent of furnishing assistants or financial aid, as this insures an intimate knowledge of the conditions of the area to the State organization, as well as a larger amount of work within the borders of the

State. In many cases, if such financial assistance be given, one or more parties can be assigned for continuous work in a State where, if the expenses were all borne by the Bureau of Soils, a party could be assigned for only a portion of the season. Various State organizations have contributed $1,839.15 toward the field expenses of the soil survey during the past year.

These soil surveys are in the nature of a general reconnoissance of the area. They show the conditions which prevail, and the maps show the character and distribution of the soils. This is, however, merely a basis for further work, and it is necessary in many cases that the information thus furnished and the suggestions which are made should be followed by further investigations and practical demonstrations of the efficiency and commercial value of the suggestions in order to insure their successful adoption by the residents of the area. Farmers are proverbially ultraconservative as to their methods, and are usually, and often justifiably, very unwilling to accept advice unless it can be shown that improvement will surely follow. Such demonstration work can, in most cases, be better accomplished by the stations than by the Department of Agriculture, for the station forces have a more intimate knowledge of the conditions and of the people, and are, as a rule, in closer touch with the people than is the Department, and with these reports and maps they have the basis for further work in the improvement of the agricultural conditions of the area, upon which they can expend their full energy and all the resources at their command. If the soil-survey work is not followed up on these practical lines, much of the efficiency and value of the work will surely be lost.

As pointed out in my last report, the experience of the men engaged in this work is likely to be invaluable, not only to them, but to the country as well. Spending, as they do, from three to nine months in an area, making a critical study of the soils, crops, methods of cultivation, and market and transportation facilities, and bringing together this experience from all sections, the men have unusual opportunities for securing a wide knowledge of the agricultural industry of the country and its resources. This is training up a class of men fitted to observe and appreciate resources and advantages that should be of great value in the further development of the agricultural interests of the United States as the country becomes more thickly settled and the strife for commercial supremacy becomes greater. As these men become riper in experience and judgment and have a fuller knowledge of the agriculture of the country, they will doubtless be called to positions of trust and responsibility in State organizations and in commercial enterprises in which their experience and ability will be invaluable. This is and should be one of the important functions of the Department, and the influence of the Department will be felt more and more throughout the country as these men are called to such positions.

PAST AND PROPOSED WORK OF THE BUREAU OF SOILS.

The statements following show the results that have been accomplished during the past year and the work that is proposed during the present and the next fiscal year in each of the States. This is of course subject to change as to details as the time approaches for the actual prosecution of the work. It is given as the basis for the continuation and extension of the work.

ALABAMA.

No work has been done in this State during the past fiscal year, but it is proposed this fall to make a soil survey of Perry County, which lies partly in the black calcareous prairie belt and partly in the sand region. Two parties will be assigned to this area in October, with the expectation that the whole of the county can be surveyed during the present field season. On the completion of this work both parties will be transferred to Mobile County to make a soil survey of that area, particularly in the interest of the truck growers, and to investigate the adaptation of the soils to tobacco. After this it is contemplated to make a soil survey in Marshall County in the interest of the fruit and tobacco growers, and to survey Lauderdale County, if possible. In all, it would be advisable to spend nine months in Alabama during the next field season.

ARIZONA.

During the past field season a soil survey was made of the area below Yuma, where the waters of the Colorado River are taken out for irrigation. The whole area covers about 95 square miles, although only a portion of it is at present under ditch. A considerable part of this area is subject to overflow during flood times in the Colorado River, and schemes have been proposed for dikes and levees to prevent this overflow, which, if carried out, will add a considerable area of valuable land to the irrigated district. This tract, with its tropical climate and fertile soils, has been compared to the delta of the Nile, and it is the intention of the Department, through its soil survey and through the work of the Bureau of Plant Industry, to see if crops equally as valuable as those cultivated along the Nile and adapted to this tropical climate can not be introduced.

This party was in charge of Mr. J. Garnett Holmes, who has had considerable experience in soil survey work in other parts of Arizona and in southern California.

It is believed that the information obtained in this work will be the basis of most valuable economic development in the introduction of crops from Algeria and Egypt. There is quite a variety of soils of different character in this area, and while there is considerable trouble with alkali it is believed that this problem can be easily controlled and that the locality will develop into one of the important irrigated districts of the West.

It seems advisable to spend three months in a soil survey of the upper Gila Valley around Solomonville during the next field season.

ARKANSAS.

No soil surveys have been made in this State during the past fiscal year, but a party is at present in the State, making a survey around Stuttgart. It is impossible at this time to make any statement as to the economic results of this work.

CALIFORNIA.

Soil surveys have been carried on in three areas during the fiscal year, namely, around Imperial in the Colorado Desert, in the Salinas Valley, and in the Ventura area.

The work in the Salinas Valley was undertaken particularly in the interest of the sugar-beet growers. This was formerly a great wheat area, but in recent years the yield of wheat has fallen almost below the point of profitable production and barley has taken its place to a

considerable extent. The rainfall, however, is so variable that crops are uncertain without irrigation, and irrigation systems are now being planned, particularly for the sugar-beet industry, which has developed to large proportions.

This party was in charge of Mr. Macy H. Lapham, and the area surveyed covered 344 square miles. Eleven different types of soils were recognized and their relation to the various crops determined. The relation of these soils to crops had been recognized to a certain extent, but the orderly classification of the soils can not fail to be of value in the future development of the agriculture of the area, especially as the industry is at present changing and developing along new lines.

All of the soils capable of cultivation in Ventura County were surveyed by a party under the charge of Mr. Holmes, the area aggregating 240 square miles. There are several valleys where irrigation is practiced, the most extensive being the valley of the Santa Clara River. Over a large part of the area, however, crops are grown without irrigation, the principal crops being lima beans, sugar beets, and barley.

The soils of the upper part of the Santa Clara Valley are generally well drained and free from alkali. Extensive areas of the delta lands, including some of the most fertile soils of the county, are deficient in drainage, and the alkali problem is becoming more and more serious. As a result of the survey, and from experiments that have been made at the suggestion of the Bureau, it is evident that the alkali problem can be economically and efficiently controlled. Thirteen types of soils were recognized in this area and their relation to crops reported upon.

From the results attained in the irrigation of the area below Yuma, and from the exceedingly arid climate, it was believed that the Colorado Desert afforded exceptional facilities for the introduction of certain tropical plants, as well as for Egyptian cotton and other products successfully grown in Egypt and on the Algerian Desert. In furtherance of this idea, a company was organized under the laws of Mexico to construct a canal through Mexican territory and deliver water from the Colorado River to a point near Calexico, on the border line between this country and Mexico, to a company chartered under the laws of the United States to distribute the water to settlers in the Colorado Desert. The land was taken up under the homestead and desert-land laws and water rights purchased from this company for the irrigation of the lands. It was realized that it was very desirable, as this enterprise was starting, to make a soil survey in order to classify the soils and determine their alkali content and their relation to crops. Accordingly, Messrs. Means and Holmes were assigned to this work, and an area of 169 square miles was surveyed around Calexico and Imperial.

This country lies at or somewhat below sea level, the Salton Sink, the lowest portion of the desert, being about 270 feet below sea level. Five distinct types of soil were recognized in this area, ranging from a loose, incoherent dunesand to a very impervious clay, and including a sand, a sandy loam, and a loam. The area is everywhere underlain with a stiff, impervious clay containing alkali. The Imperial clay is difficult to cultivate, and water penetrates it very slowly. Large areas of alkali lands were encountered, and it is estimated that about 54 per cent of the area has more than 0.4 per cent alkali as an average for 6 feet in depth. There are serious problems, therefore, to be

encountered in the successful development of agriculture in the area. It is believed that about 50 per cent of the area can at present be cultivated in nearly all crops adapted to the locality, while a considerable portion of the remainder may be reclaimed by drainage, or can be used for alkali-resistant crops.

The importance and necessity of having this knowledge of the soil conditions has been recognized, and very urgent requests have been received for an extension of the soil-survey work to embrace practically all of the lands in the Colorado Desert which can be irrigated, as a basis for the intelligent cultivation of this area, and to insure, as far as possible, the successful settlement of the country. Recognizing the importance of this work, it is proposed to combine a number of our field parties and place them in the area during the coming fall and winter to make a soil survey of about 1,500 square miles of the Colorado Desert, so that settlers may know the actual character of the soils which they purchase, and that industries can be established on the soils best adapted to them.

In addition to this work it is proposed to extend the soil survey to the Santa Clara Valley in the interest of sugar-beet, grain, and stock production, and to take up the San Bernardino Valley in southern California, which is the last of the great fruit areas in southern California that remains to be surveyed. It is believed that very valuable results will be attained by the soil survey when it is extended to the sugar-beet area around Chino and the fruit areas of Pomona, Riverside, San Bernardino, and neighboring towns.

In all it appears desirable to spend twenty-one months, on the basis of one party, in the State of California during the next field season, and it is believed that the importance of the areas to be investigated fully justifies the time and attention to be given to the work.

COLORADO.

During the present field season a soil survey is being made, under the charge of Mr. Macy H. Lapham, of the irrigable lands of the Arkansas Valley between Rockyford and the Kansas State line. There will be nearly 1,000 square miles of intricate soil mapping, with alkali problems to be worked out, but it is believed that by concentrating some of the northern parties in this area during the fall the whole area can be surveyed. This work is undertaken principally in the interest of the sugar-beet growers and of the melon and truck growers. Not only is it desirable to understand better the relation of the soils to crops, but with the extension of irrigation systems the natural drainage is found to be deficient and alkali is rising and threatening trouble and losses. The work has progressed far enough to indicate that the alkali problem can be economically and efficiently controlled, and it is believed that the classification of the soils will give a basis for the most profitable development of the sugar-beet and truck interests of the area.

It appears desirable to spend about six months during the next field season in a survey of the San Luis Valley, where the alkali problem is becoming far more serious even than in the Arkansas Valley.

CONNECTICUT.

No extension of the soil survey has been made in the Connecticut Valley since 1899, but with the extension of the profitable industry of producing the shade-grown Sumatra tobacco there is a very strong demand now that the survey should be extended to include many

smaller valleys on either side of the area surveyed in 1899, and it is proposed to spend about three months in the State during the next field season, to give a basis for the extension of the tobacco industry on either side of the main valley.

DELAWARE.

No surveys have been made as yet in Delaware, and none is contemplated during the present year. There is, however, a demand for a soil survey to extend over the entire State, and it seems desirable to spend three months in the State during the next fiscal year in such work.

FLORIDA.

No surveys have been made in this State up to the present time, but it is proposed, if suitable arrangements can be made for a base map, to make a soil survey in Gadsden County in the interest of the tobacco growers.

GEORGIA.

During the past fiscal year two areas were surveyed in Georgia, including Cobb County and an area around Covington, the former being under the charge of Mr. R. T. Avon Burke and the latter of Mr. Herbert W. Marean.

It was hoped that the survey in Cobb County would show the possibilities of fruit raising, but it is believed that the prospects for this industry are not so favorable in this locality as they are farther north, and it is therefore proposed to extend the survey to include the northern half of the Ellijay sheet of the United States Geological Survey to include portions of Union, Gilmer, and Fannin counties in the interest of the fruit growers and as an extension of the survey in the mountain areas in Virginia and North Carolina. It is intended to give about six months to this work during the next field season, and it is also proposed to survey an area in Decatur County in the interest of the tobacco growers.

HAWAII.

No soil survey has been made in this Territory as yet, but there have been strong demands for the work, and a recommendation will be made for needed legislation to permit the Department to extend its soil survey work to that Territory at an early date.

IDAHO.

A soil survey party, under the direction of Mr. C. A. Jensen, has completed a survey of the Boise area, extending from Boise City to a point some distance west of Caldwell and including the principal irrigated lands of that section. Serious problems were encountered in this area in the occurrence of hardpan in the soils, and there were other soil problems upon which advice was given which it is believed will be of material economic value in the agricultural development of the area, which is assuming considerable importance.

A party, in charge of Mr. Louis Mesmer, has been assigned to survey the area between Lewiston and Moscow. The wheat yields in this area have declined, and the people are anxious to introduce forage crops, and the soil survey work is to be used as a basis for the consideration of this problem.

Representations have been made to the Department which make it appear advisable to spend about six months in the next field season in the survey of the irrigated lands of the Blackfoot area.

ILLINOIS.

Through cooperation with the Illinois experiment station the Bureau was enabled to put two parties in the field during the early part of the present field season, and at the close of the fiscal year had made a soil survey of Tazewell and Clinton counties, under the direction of Mr. Jay A. Bonsteel, and a portion of St. Clair County, under the direction of Mr. George N. Coffey. During the remainder of the present field season it is proposed to finish St. Clair and Clay counties, if time permits. So far as this work has been examined, particularly the finished maps of Tazewell and Clinton counties, it is believed that the results will be of material benefit and value to the farmers. Thirteen soil types were recognized in Tazewell County and seven in Clinton County and their relation to crops reported upon.

A copy of the soil map and report on the Tazewell area has been sent to one of the most intelligent and progressive landowners, with the request that the work be critically examined and freely criticised, so that we may get advice in advance of publication as to the practical utility and usefulness of the work and suggestions as to other lines that could be profitably developed.

So far as the Bureau is at present informed this work has aroused a great deal of interest, and it is believed that it will be of value to the people. Requests have been made for upward of 25,000 copies of each of these reports, with accompanying maps, to supply the local demand which is likely to arise. So much interest has been taken in this survey that urgent requests have been made by the Illinois experiment station that the work shall be continued in the State, and it is proposed to assign a party to the State for the entire field season of nine months during the coming year. It is understood that the station will continue its cooperation, and possibly arrangements can be made for more than one party, so that the work may progress rapidly.

One of the most serious problems encountered in the soil survey, particularly in Clinton County, is in the hardpan, or the compact nature of the underlying clay subsoil, in some of the soil types. This not only renders cultivation difficult, but makes crops uncertain under certain climatic conditions, and an investigation of the cause of this and a possible remedy is now engaging the attention of the laboratories of the Bureau.

INDIANA.

No work was carried on in this State during the past fiscal year, but a party is at present engaged in making a soil survey of Posey County. This is in charge of Mr. Marean, and the whole area of the county is to be surveyed. This is particularly in the interest of the truck growers, as large quantities of watermelons and other truck crops are produced on some of the sandy soils of the area.

While there has been some demand for the extension of this work to include the whole area of the State, the plans at present contemplate a survey of only three months' duration in Boone County during the next field season.

IOWA.

During the past fiscal year a soil survey has been made around Dubuque, under the charge of Mr. E. O. Fippin. Eight soil types have been recognized and their relations to crops reported upon.

Rather strong demands have come for the continuation and extension of this work to include the entire State, but it is proposed to

spend but six months during the next field season in surveying a part of Cerro Gordo and Story counties in the interest of sugar-beet production, as well as of general farming, stock raising, and dairying.

KANSAS.

During the past field season 461 square miles have been surveyed around Wichita. It was expected that this would be a very uniform area, but nine soil types were encountered, each with distinct properties and adapted more or less to different crops or requiring different methods of cultivation. The possibilities are shown of some degree of specialization of crops and the introduction of fruit interests to take the place of the almost universal crops of wheat and corn, which it is believed will be of value in the further development of the agricultural interests of the area. This work has been in charge of Mr. J. E. Lapham.

It seems desirable to spend about six months in the survey of a portion of the Parsons sheet of the Geological Survey, in the north-central part of the State, in what may be considered the beginning of the semiarid portion of the West.

KENTUCKY.

During the past fiscal year a survey was made of Union County, which has an area of about 330 square miles, under the charge of Mr. Marean. Eight types of soil were recognized, and while apparently the soils are quite uniform in texture and natural fertility, the possibilities of introducing new industries and better methods of cultivation were clearly indicated. At present the area is given up almost exclusively to wheat culture, but there are good opportunities for greater diversification through improvements in the management of soils, the rotation of crops, and in growing products new to the area.

Demands for soil-survey work in Kentucky have been quite strong, and it seems desirable to assign a party to that State for nine months during the next field season, the surveys to include Henderson, Christian, and Scott counties. This work will be mainly in the interest of the tobacco growers, stock raisers, and general agricultural interests.

LOUISIANA.

A soil survey was made during the last fiscal year by Mr. W. H. Heileman in the Lake Charles area in the interest of the rice growers, an area of 202 square miles having been covered. Six types of soil were recognized in what was supposed to be a uniform area, and it was found that the relation of these soils to the yield of rice was quite marked, and the desirability of extending the survey to other rice districts was clearly recognized. Moreover, under the present system of exclusive rice culture, not even sufficient food for the stock is produced, while meat and vegetables for the support of the people are imported in large part from other States. There is no reason for this so far as the soils or climatic conditions are concerned, and it is pointed out that a proper diversity of interests would materially add to the welfare of the community.

It seems desirable to spend three months during the next field season in Arcadia Parish in the interest particularly of the rice, sugar, and tobacco producers.

MARYLAND.

Very strong demands have come for the continuation of the surveys in Maryland to include the whole of the State, and particularly of

Worcester, Somerset, and Baltimore counties, and it is proposed to assign a party there for six months during the next field season.

During the past fiscal year Harford County, covering an area of 418 square miles, has been surveyed by a party under the charge of Mr. W. G. Smith. There is no place where the survey has been carried on where more interest has been manifested and more use has been made of the work than in this State. Possibilities have been shown, particularly in Prince George, St. Mary, and Calvert counties, of the specialization of crops in the line of fruit growing, trucking, and general farming and dairying, which would very materially benefit the people and add greatly to the prosperity of the community.

While much work has already been done in this State, it is believed that the intelligent interest and appreciation shown in the results of the work justify the Department in pushing the surveys and giving the people the information they seem to need, and which they appear ready to benefit by in the practical extension of their agricultural interests and in developing the prosperity of the State.

MASSACHUSETTS.

No work has been done in this State since 1899, and the establishment of the profitable Sumatra tobacco culture has aroused a decided demand for the extension of the survey of 1899 in the Connecticut Valley northward to the State line and on either side of the area which has already been surveyed. It is proposed to spend three months during the next field season in the extension of this work, in the interest particularly of the tobacco growers.

MICHIGAN.

During the past fiscal year Allegan County, covering an area of 828 square miles, has been surveyed under the direction of Mr. E. O. Fippin. This work was undertaken particularly in the interest of the fruit growers along the lake shore and of the sugar-beet and general agricultural interests. This appears to be one of the most valuable pieces of work the Bureau has done, and it is believed that the results, which form a part of the report of the field operations for 1901, will be of very great value to the people in the extension of their present industries, the improvement of methods of cultivation, and the development of new crops, which it is believed can successfully be introduced. The experience of the people of this section will also prove of value to other communities, and the lessons taught by the soil survey will, it is believed, have value outside of the area.

No work is contemplated for this State during the next field season, but strong demands have come for an extension of the survey, and it is believed that it should be resumed at the earliest practicable time, particularly in the interest of the sugar-beet and fruit growers.

MINNESOTA.

No work has been done in the State, but strong demands have come for the extension of the soil survey, and it seems desirable to assign a party there for six months during the coming field season, the first area to be surveyed being probably Lyon County.

MISSISSIPPI.

During the past fiscal year the Bureau has mapped an area of 656 square miles around Yazoo City, the work being in charge of Mr. Jay A. Bonsteel.

About one-third of the area is in the uplands and two-thirds in the Yazoo and Mississippi Delta. The upland soil is a typical loess, and it has been suggested, as a result of the survey, that alfalfa can be produced on it as a basis for stock raising. In its present condition it is little esteemed as a cotton soil.

It was supposed that the delta would present a very uniform soil condition, but four soil types were recognized, each with very distinct agricultural values. The Yazoo clay is the most productive cotton soil, yielding from 1⅛ to 1⅜ bales per acre, and even more under the best methods of cultivation. This, however, covers only about 17 per cent of the delta. The Yazoo loam, covering about 6 per cent of the delta, yields from three-fourths to 1 bale of cotton per acre. The Yazoo sandy loam, covering 9 per cent of the delta, produces about three-fourths of a bale to the acre, while the Sharkey clay, covering 68 per cent of the delta, is not cultivated on account of the annual overflow. The flood waters leave the land about the 1st of June, but although the land is subsequently dry it is then too late for crops to be put in.

It has been pointed out, as a result of this soil survey, that the Yazoo sandy loam is a typical early truck soil, and that, with the prevailing climatic conditions, potatoes or other truck crops would prove a remarkably profitable industry on this soil.

The Sharkey clay is a wonderfully productive soil, and it appears from the investigations that have been made that the engineering problem of protecting it against the annual floods would not be very difficult, nor expensive when the value of the soil so reclaimed is considered. It is believed that these three suggestions, if followed by the people, will well repay the money expended in the survey.

It is proposed to continue and extend this work to include a larger area of the delta lands and possibly to take up one other area in the State, devoting in all about six months in the next field season to the work.

MISSOURI.

During the latter part of the past fiscal year Mr. Fippin was assigned to survey Howell County, in the fruit area of the Ozark region. It is probable that the whole area of this county will be surveyed during the present field season. It has been found that the soils are remarkably uniform and that the fruit interests can be extensively developed, but it is advisable that the methods be improved to attain the highest commercial success.

The demand for the continuation and extension of this work in Missouri has been so great that it seems desirable to assign a party there for nine months for the survey of Shelby, Saline, and Webster counties during the next field season.

MONTANA.

During the past fiscal year the Billings area, comprising about 105 square miles, has been surveyed under the direction of Mr. C. A. Jensen. Considerable trouble and loss has resulted from the rise of alkali in this area, and the survey was planned with particular reference to determining the possibility of preventing this trouble and reclaiming the land already damaged. It is considered quite feasible to accomplish this object, and it is probable that a demonstration will be made of the efficiency of proper drainage in preventing the rise of alkali and in reclaiming the alkali soils of this locality.

It would seem desirable to assign a party to this State for six months in the next field season to make surveys in the Gallatin Valley and in the Milk River Valley around Glasgow.

NEBRASKA.

No work has heretofore been done in this State, but it is proposed to assign a party for nine months of the next field season to make soil surveys of the Grand Island and Holdrege areas in the interest particularly of the sugar-beet industry.

NEW JERSEY.

During the fiscal year just passed a survey of the Salem area, comprising 493 square miles, was completed under the direction of Mr. Bonsteel, and a survey of the Trenton area, under the charge of Mr. Burke, has been started and will be completed during the present field season.

The Salem area lies wholly within the Coastal Plain region and has eleven different types of soil. These are adapted to various truck crops, fruit interests, and general farming. The people have already recognized the relation of the soils to crops and have adapted their industries to the various soil areas. The success has been so remarkable that the lesson may well be carried to other localities along the Atlantic coast where similar soils prevail.

The Trenton area lies partly in the Coastal Plain and partly in the Piedmont Plateau, and gives even a wider range of soils. This area is particularly adapted to specialization of crops and the building up of widely different agricultural interests.

The interest in this work justifies its continuation, and it seems desirable to spend six months during the next field season in the survey of the Monmouth Shore area, east of and immediately adjoining the Trenton area.

NEW YORK.

During the past fiscal year a soil survey was made of the Westfield area under the direction of Mr. Burke, and of the Elmira or "Big Flats" area under the direction of Mr. Mesmer.

The Chautauqua grape belt, extending for 30 miles along the Lake Erie shore, is within the first-named area. The old beaches, where the grape industry was first developed, have been outlined upon the map, and the Dunkirk clay, upon which the industry has since been developed, is also located, as well as several other foreland and upland soils adapted to general farming and dairying.

The survey of the Elmira area was undertaken particularly in the interest of the tobacco growers, and more especially to see if the cultivation of Sumatra tobacco could be extended there, and to form a basis for other tobacco investigations for the improvement of their present crops. The results indicate that the Sumatra tobacco can not successfully be produced within the area surveyed, except in one small area of not over 10 or 15 acres, where it might be grown. An experiment is in progress to determine this point, although this is not under the control of the Department. The results of the survey point to the need of further investigations of these soils, which under the present methods of cultivation require large annual applications of stable manure to produce satisfactory yields of the crops of the locality. There is an opportunity here for the work of the new division of soil management, which would probably yield results of value to the people.

During the present field season the survey has been extended to the Lyons area in the interest particularly of the sugar-beet growers. It is proposed during the coming field season to detail a party for nine months to make a soil survey of the whole of Long Island. This is particularly in the interest of the truck growers, and it is believed that the results will be of considerable interest and value.

NORTH CAROLINA.

During the past fiscal year a survey has been made of the Alamance County, Cary, and Craven areas under the direction of Mr. Coffey and of the area around Hickory under the charge of Mr. Caine.

Alamance County is in the Piedmont Plateau, and the work was undertaken in the interest of the cotton growers and general farming. Formerly this was an important bright-tobacco section, but the growth of this industry in the eastern part of the State has been the cause of a decline in tobacco production in the area, and the soils formerly adapted to this special industry have depreciated considerably in value. Various suggestions of a practical nature in the line of improved methods of cultivation and the introduction of new crops and new industries have been made as a result of the soil survey.

The work in the Craven area was carried on particularly in the interest of the truck growers and in order to outline the truck soils in this area, which is not as yet very thickly settled.

The work in the Hickory area was in the interest of general farming and, in the mountainous portion, of fruit growing. It is proposed to extend this work during the present field season to the Mount Mitchell area in the interest of the fruit growers.

There is no more interesting development at the present time in the Atlantic coast States than that of the fruit interests in the mountains of Virginia, North Carolina, Georgia, and Alabama. From the work so far done in these States it is clearly apparent that the soil has an important bearing on the different fruit crops, and the apple and peach soils can be identified and outlined as a basis for the intelligent development of these industries. Not only are certain soils adapted to apples, but certain varieties of apples do better on some soils than on others, and the same is probably true of other fruits.

The North Carolina department of agriculture has cooperated very cordially and very helpfully in this work, and it appears desirable to continue this cooperation, assigning a party there for nine months during the coming field season to extend the soil survey.

NORTH DAKOTA.

Very strong demands have come from this State for the extension of the soil survey to include most of the arable portion of the State. It has been impossible until recently to start the work there, but a party has just been assigned to the Grand Forks area, in the Red River Valley, under the direction of Mr. Jensen, who has had wide experience in similar areas in Utah and Montana.

Considerable quantities of alkali are encountered, but generally at a sufficient depth below the surface to enable the annual crops to be produced. The surface foot is usually free from alkali, and as there is no irrigation, and little chance for irrigation, it is believed that there is little danger of the alkali coming to the surface and spreading. It seems a risky thing, however, to have the valuable crops of the locality growing over and so close to these alkali salts, and the possibility of the rise of this alkali should be fully investigated. If

it were in an area where water was available for irrigation, it could safely be predicted that the land would quickly be injured by the rise of alkali, but with no opportunity for irrigation the chances are that conditions may not become more serious than at present. This is a question, however, that these investigations will have to solve. The work is being carried on in cooperation with the State geologist.

It seems desirable to assign a party to this State for six months' work during the next field season.

OHIO.

During the past fiscal year work has been started in the Columbus area and in the Toledo area, and it is believed these will both be completed by the end of the present field season. The surveys are being made under the direction of Mr. W. G. Smith.

The Columbus area is devoted to general farming. While there is a certain uniformity in the soils, one of the principal soils is preeminently a wheat land and another chiefly a corn land, the character of the soils showing very strongly their peculiar agricultural values in the crops produced and in the success of these crops.

It is proposed to assign a party to this State during the next field season to survey a part of Ashtabula County in the interest of the fruit and tobacco growers.

OREGON.

No surveys have been made in this State, but it is proposed to assign a party there for six months during the next field season to survey an area around Salem, in the Willamette Valley.

PENNSYLVANIA.

During the past fiscal year a survey of the Lebanon area, in the interest of tobacco growers and general farming, was completed under the direction of Mr. Smith. The interest taken in the survey around Lancaster leads me to believe that the results of this work will be found of interest and practical value in the still higher development of the agricultural conditions of the locality.

It seems desirable to assign a party for three months during the next field season to make a soil survey of Clinton County, particularly in the interest of the tobacco growers.

PORTO RICO.

During the past fiscal year an area of 330 square miles was surveyed in a strip about 10 miles wide, extending from Arecibo to Ponce, the work being in charge of Messrs. Dorsey and Mesmer. Twenty-two types of soils were recognized, all of them markedly different from the soils encountered in the United States. Much of the country is rugged, broken, and mountainous, and as there were no available maps, the base map had to be made as the soil survey progressed. Many of these soils are not well adapted to agriculture, but the report deals fully with the conditions as they were actually seen, and it is believed that it will form a basis for a more intelligent development of the agriculture of the island.

It is deemed advisable that this survey should be extended to include the whole area of the island, of which about one-tenth is included in the area already surveyed, but under a change made in the wording of the appropriation bill it will be impossible for the Bureau of Soils to continue this work. It will be recommended that such changes be made in the next appropriation act as will enable the Department to

resume operations in Porto Rico. I know of no more valuable work the Department can do than to thus investigate the actual conditions in these island possessions, and the extension of the soil survey to them should give a basis for the best and most economical development of their agricultural resources at a time when so many people are looking to these islands for investments and when the people of the islands themselves need all the help that can be given them.

SOUTH CAROLINA.

During the past fiscal year an area of 686 square miles has been surveyed around Abbeville, and on the completion of this work the party, in charge of Mr. Taylor, will make a survey of Darlington County, particularly in the interest of the bright-tobacco growers and truck growers.

It is proposed to detail a party for nine months during the coming field season to survey an area in Spartanburg, Pickens, and Orangeburg counties, particularly in the interest of the cotton, fruit, and bright-tobacco growers.

SOUTH DAKOTA.

No surveys have been carried on in this State, nor are any contemplated for the present field season. It seems desirable, however, to assign a party for a period of three months during the next field season to start a survey in Brookings County.

TENNESSEE.

During the past fiscal year a survey in the interest of the tobacco growers was made of Montgomery County, embracing an area of 547 square miles, under the direction of Mr. J. E. Lapham. Among the important results of this survey has been the suggestion that one type of soil which is at present of little agricultural value and which covers a considerable area, is adapted to fruit growing, and it is believed that this interest could be introduced with profit to the community. It was hoped that the survey would be the basis of an investigation of the possibilities of improving the tobacco interests, but the appropriation for the Bureau was not sufficient to enable this to be done.

It is proposed to extend the soil survey to Greene, Cumberland, and Davidson counties, assigning a party to this work for a period of about nine months during the coming field season.

TEXAS.

During the past field season the Willis area of 215 square miles has been surveyed in the interest of the tobacco growers, and a party of tobacco experts has been placed there to investigate the possibility of producing a more desirable filler tobacco.

The Alvin area was also started under the direction of Mr. Bennett, and this and the Brazoria area will probably be completed during the present field season. This is particularly in the interest of the fruit growers around Alvin and of the sugar interests around Brazoria.

It is also proposed to survey an area during the present field season around Vernon, in the Panhandle of Texas, in the interest particularly of the wheat growers and with the view that the results may be useful in the introduction of macaroni wheat.

Representations have been made to the Department which make it appear advisable to assign a party to this State for at least nine months during the next field season for surveys, particularly in Tyler County, and also around Austin and San Antonio.

UTAH.

The soil-survey work of 1899 and 1900 has been discontinued in this State, but it is proposed to assign a party for six months during the next field season to survey the irrigable lands around Utah Lake.

The work around Salt Lake City is being followed up by a drainage investigation having for its object the reclamation of some of the alkali lands.

VERMONT.

A strong demand is made for the extension of the soil survey in the Connecticut Valley in the interest of the tobacco growers, to see if the cultivation of the Sumatra tobacco can not be extended to that latitude. It is proposed to assign a party for three months during the next field season to extend the soil survey of the Connecticut Valley.

VIRGINIA.

During the last fiscal year the Bedford area and the Prince Edward area have both been completed, and the Harrisonburg area has been begun. All of this work has been under the direction of Mr. C. N. Mooney. It is proposed to finish the Harrisonburg area and the northern part of the Buckingham sheet of the Geological Survey during the present field season, and to assign a party to this State for nine months during the next field season to survey the southern half of the Buckingham sheet and the whole of the Harpers Ferry sheet, as well as an area around Norfolk.

The most important work has been done on the Bedford and Harrisonburg areas. These include portions of the Piedmont Plateau, of the Valley of Virginia, and of the intervening mountain area. The results of the work on the plateau and in the valley are important, but the greatest interest centers in the survey of the mountain soils, in which the fruit interests are developing. It has been found that the different varieties and types of fruit are best adapted to different soils, and as the survey extends and these soils are being outlined the basis is presented for the most intelligent development of the fruit interests.

The Harpers Ferry area will take in a considerable portion of the valley, as well as of the plateau, and the results of the work should show the reason for the decline in agricultural value of the valley soils, and should suggest means for reviving the agricultural interests of what was once a prosperous community on what was considered the highest type of agricultural land.

The survey around Norfolk will be in the interest of the truck growers.

WASHINGTON.

During the past fiscal year the Walla Walla area, covering about 150 square miles and including practically all of the irrigable lands of that locality, was surveyed under the direction of Mr. Holmes. The work has just been finished and the results can not yet be reported.

WISCONSIN.

No work was done in the past fiscal year in this State, but Mr. Jay A. Bonsteel was assigned on July 1 of the present fiscal year to the Janesville area to survey the soils around Janesville, Stoughton, and Edgerton. This survey is in the interest of the tobacco growers, and is particularly to see if the Sumatra tobacco is likely to be adapted to this section, and to be a basis for the improvement of the type of tobacco at present grown.

It seems desirable to assign a party to this State for six months during the next field season to make a survey, particularly of Eau Claire County.

WYOMING.

No soil surveys have as yet been made in this State, but it is proposed to assign a party for six months during the next field season to survey the soils of the irrigable part of the Laramie sheet of the Geological Survey.

ESTIMATED COST OF PROPOSED SOIL SURVEY WORK.

During the fiscal year 1902 about $40,000 was spent on the soil survey with 10 survey parties. For the fiscal year 1903 an allotment of $60,000 has been made for this work with 15 soil survey parties. For the fiscal year 1904, for which estimates are being submitted to Congress, on the basis of the plans which have just been given for the continuation and extension of the work in order to meet the most urgent demands, an allotment of $120,000 would be necessary. This is based upon a total estimate of 243 months of field work contemplated by the above plans, which will require for its completion within the fiscal year 30 field parties, costing approximately $4,000 each, calculated on the basis of the work done during the last three years. Each party would survey about 1,200 square miles, making a total estimated area of 34,800 square miles, or 22,272 acres, in 38 States and Territories, which would be surveyed in that year.

PUBLICATION OF THE REPORT AND MAPS.

The results of the field work of the Bureau of Soils are published under authority of the joint resolution of Congress providing for the printing annually of the Report of Field Operations of the Division of Soils, Department of Agriculture, approved February 23, 1901. Under the interpretation of this resolution by the Public Printer, the report and accompanying papers have to be published at one time in a single volume, with the maps in a separate case. This is undesirable in many ways, for work that is finished in the winter or spring has to be held in the office until the succeeding February, when the report of the field work is all completed and sent to the Public Printer. This delays the publication for nearly eighteen months after the work is completed, and the public interests require that the work should be published as soon as possible after the completion of the field work. Furthermore, the publication of all the reports and maps in a single volume makes a bulky and expensive book to send to any person requesting information about a particular area. The demand also is so great that, although the Department has 8,000 copies of the bound report to distribute and the Senate and House of Representatives have together 9,000 copies, the Department received upward of 2,000 requests for the 1900 report which could not be filled. Reprints were ordered of all the reports, in editions ranging from 500 to 1,500 copies, and these were quickly exhausted. As the work becomes better known, many requests are coming from Senators and Representatives, and the opinion is freely expressed that the full value of the work can not be secured unless there is a liberal provision for its distribution within the area in which the work has been done. The requests for reprints of the 1901 report indicate that from 3,000 to 10,000 copies will be required to satisfy the demand, notwithstanding

the fact that some of the States are ordering reprints of the maps for their own distribution.

In view of these facts it is recommended that the joint resolution be so amended as to permit of the Report of the Field Operations of the Bureau of Soils being published in parts or volumes as the work is completed. That there should also be reprinted of the separate reports, with their accompanying illustrations and soil maps, editions sufficient to allow 500 for each Senator to whose State the survey relates, 2,000 for each Representative in whose district the survey may be made, and 1,000 for the use of the Department of Agriculture. This will insure the prompt publication of the results of the survey and a distribution through members of Congress, which my present information seems to indicate is desirable if the full value of the soil survey work is to be attained in the dissemination of the information thus gathered, promptly and freely, to the people who are interested.

Needed Legislation for Insular Surveys.

It seems desirable that the benefits derived from the soil survey work should be extended to the insular possessions of the United States, and I recommend that the act making appropriation for the Bureau of Soils be so worded as to permit of the sending of soil survey parties to Porto Rico and Hawaii. Numerous demands have come for the extension of the work in both Porto Rico and Hawaii, and it seems probable that the work will be of particular value to these islands in the present state of the building up of their agricultural resources.

The work has already been started in Porto Rico and in the Philippine Islands, the latter through cooperation with the War Department and the civil government of the islands, in the detail of Mr. Clarence W. Dorsey to the Philippine government and the defraying of his salary and the expenses of the soil survey work by that government. The work can not be continued in Porto Rico nor started by the Department in any other of our possessions without a change in the wording of the appropriation act.

Investigations in Soil Management.

In the development of the soil survey many questions are presented of the possibility of improved methods of cultivation and handling of the crops, as well as of introducing new methods, new crops, and new industries. Some of these suggestions need more time and more study than can be given by the soil-survey parties in the limited time in which they remain in an area. Furthermore, the presentation of such suggestions in printed reports is apt to fail of securing proper recognition from the conservative farmer, who follows pretty much the methods used by himself and his predecessors on the land. Without these further studies and a practical demonstration of their efficiency many of the important results of the soil survey are liable to be lost.

For these reasons a division of soil management has been instituted in the Bureau, in charge of Prof. Franklin H. King. During the past year exceedingly delicate methods have been devised for the analyses of soils in the field. They are so sensitive that the amounts of nitrates, phosphates, sulphates, and the like which may be present, as indicated by water solutions, can be determined to within 4 or 5 pounds per acre 1 foot deep. With these methods it is possible to detect throughout the year fertilizers which were applied in the spring,

and to trace the movement of these fertilizers from the place where they were applied down through the different depths of the soil. It has been found possible to show noticeable differences in the chemical composition of the soil in the same field, in some parts of which the crops are growing well, and in other parts of which they are but poorly developed. It appears that the time has arrived, looked forward to with much interest by scientists and practical men alike, when an analysis will show the need of any particular soil for certain fertilizers. It is too early to make a positive statement of this kind, but the indications are that this can soon be accomplished.

A considerable amount of work has been done with these methods on the soils of eastern North Carolina and of Wisconsin, and quite recently many of the important soil types which have been established by the Bureau in Georgia, North Carolina, South Carolina, Virginia, Maryland, New Jersey, Pennsylvania, and Wisconsin have been analyzed by these methods. These types represent all grades of soil, from the most productive to those which are quite unproductive; soils that are adapted to truck crops, tobacco, fruit, wheat, and corn; and soils under a range of climatic conditions with rainfall varying from 25 to 45 inches per annum.

The results of this work have led us to look upon the soil moisture as a great nutritive solution existing over the surface of the earth, the composition of which is everywhere approximately the same. The soil is a heterogeneous mixture of minerals, the predominant ones being silica, feldspar, mica, and other like silicates, resulting primarily from the disintegration and decomposition of igneous rocks, spread out often through the action of water over vast areas of land. All these minerals are but slightly soluble, and it is not unreasonable to expect that such a heterogeneous mixture of silicates in contact with water should yield a soil solution having sensibly the same composition and concentration. The older experimenters in Germany found that in making up solutions for water culture or for sand culture the concentration and composition of the nutritive solution must be the same within relatively narrow limits for success in plant development. The results of the past season indicate that the differences in the composition and concentration of the dissolved material in the soil moisture of various types of soil of widely different localities and of different agricultural values are little if any greater than the differences to be found in one and the same type of soil under good and under poor farm management.

The "early truck" soil of the Atlantic coast may be deficient in plant food and may require fertilizers for the best development of the crop, but even with such an application as would make these soils as rich in plant food as the prairie soils of the Middle West, these light truck soils could not economically be made to produce as large corn crops as the prairie soils. The difference in the agricultural value of these different types appears to depend not so much upon the chemical composition as upon the physical properties of the soils, and especially upon their relation to moisture. In other words, the chemical characteristics of the soil influence the yield of crops, while the physical characteristics have generally the greater importance in determining the kind of crop adapted to the soil.

This work will require much further investigation before these statements can be definitely proved, but the amount and character of the evidence so far obtained is such that these ideas may be taken

safely as working hypotheses. They are now serving us in this capacity in suggesting and giving direction to studies which are confidently believed to have far-reaching importance for agricultural methods and practice, studies which in all probability could not have been conceived or planned without the investigations which have just been briefly outlined. The results of the work indicate, as might be expected, that the composition of the soil moisture is largely influenced both by the cultivation and by the cropping of the soil, and appear to show in what way and to what extent cultivation can be depended upon to change these important characteristics.

The results of the last year's work also seem to indicate the very superficial nature of the droughts which so seriously affect crops in the Eastern and Middle Western States. It has been frequently observed that in a time of drought, when the surface soil becomes desiccated and the plants are suffering, the subsoil at a depth of 1 or 2 feet contains but little less than the average amount of moisture, and it has frequently been observed that the crops are much more shallow rooted than they are in the far West. This has been variously ascribed to the uniform texture of the soils and subsoils in arid regions, and to other reasons, but the true explanation seems to be that with our frequent and excessive rains in the spring and early part of the growing season, the crops find sufficient moisture near the surface and develop a superficial root system. When the drought comes and the surface soil loses its moisture, the crop suffers because it is not provided with a deeper root system. In the far West, where spring and summer rains are rare, the crop is planted upon a soil which is always uniformly moist to a considerable depth, and with no subsequent rains the plant develops a deeper root system, which enables it to survive long periods of drought that would seriously affect it if it was subjected to frequent showers during the early period of its growth. It is a familiar fact that a lawn which once is watered during a dry season will have to be frequently watered or the grass will suffer oftentimes more than if it had not been watered at all. The first watering induces a superficial root development, which must be supplied frequently with water. What can be done to prevent this tendency and to overcome the effect of droughts is a subject of the utmost importance, and one which will receive the attention it deserves.

I know of no line of work which has been undertaken of more fundamental importance than the work of the division of soil management, nor one which offers a promise of more valuable results to the agricultural interests. When these fundamental problems have been established they will give a reliable basis for the development of better methods of cultivation, fertilization, and of cropping.

Tobacco Investigations.

Since my last report the commercial success of the shade-grown Sumatra tobacco in the Connecticut Valley has been assured. Last year 41 acres of shade were erected by 13 farmers, cooperating with the Department of Agriculture, 35.88 acres of which were planted to Sumatra and the rest to the ordinary Connecticut Habana seed tobacco. The expenses of this work, amounting on an average to about $657 per acre, were borne by the farmers, the Department of Agriculture exercising supervision over the work and directing all the operations. The Department also reserved the right to offer the tobacco for sale, for the purpose of obtaining official information as to the commercial

value of the product, which it would have been impossible to obtain if the tobacco had been disposed of at private sale. Accordingly, after it had been carefully cured and assorted under the direction of the Department's experts, the tobacco was catalogued and offered for sale at public auction at Hartford, Conn., on May 1, in accordance with the wishes of the various growers. A committee of tobacco brokers, with Hon. E. Stevens Henry, Congressman from the First district of Connecticut, as chairman, was invited to cooperate with the Department in the management of this sale. The committee consisted of Messrs. M. E. Flaherty, New York; Steven G. Ruth, New York; S. M. Seymour, New York; Capt. Darius Ferry, New York; James Ertheiler, New York, and Herman G. Vetterlein, Philadelphia.

The committee took a great deal of interest in the work and rendered very efficient services in the matter. Credit is due them for the time and expense which they personally contributed in the interest of this investigation and of the Connecticut growers.

The tobacco was offered for sale at public auction from sworn samples. As each grower wanted to sell his crop independently of the others, many of the bales had mixed sizes and even mixed grades. Furthermore, the leaf had not been tried by the manufacturers, and there was some hesitancy in bidding on this account. This accounts for the considerable variation in the price. It is estimated by the Department's experts, as stated in Bulletin No. 20 of the Bureau of Soils, that the tobacco cost on an average, baled and ready for market, about 51½ cents a pound. The ordinary tobacco grown in the open fields in Connecticut brings on an average from 18 to 20 cents a pound. The average price paid for the shade-grown tobacco was $1.20 a pound, the price varying from $2.80 per pound for the best to 25 cents a pound for some of the mixed bales. The crop that brought the best price sold for $1.63 per pound on the average.

On the whole, it is believed that the auction sale was very satisfactory, but it is thought that the prices for this year's crop will be even higher, as indicated by the great demands for the product and by the favorable reports that are coming in from the cigar manufacturers who have used this leaf. The aggregate of the prices obtained at the auction shows a very handsome financial transaction.

The total area cultivated in Sumatra tobacco in 1901 was 35.88 acres. There were produced 51,308 pounds of cured tobacco, and actually baled 41,046 pounds, the difference being the loss on account of fermentation, trash, and filler leaves. The total cost of production, estimated at $657.17 per acre, was $23,579.26. The total value, estimated at $1.20 per pound, the average price obtained at the sale, was $49,255.20. This gave a net profit to the growers of $25,675.94, or 108.8 per cent. This does not include the cost of the land, barns, or warehouses, nor the interest on the investment so represented, but does include the whole cost of the shade, the framework of which is expected to last for from five to eight years. The profits per acre were as follows: Of baled tobacco, exclusive of trash, there was obtained 1,144 pounds per acre; the cost of this was approximately $657.17 per acre; the value, at $1.20 per pound, was $1,372.80, giving a net profit of $715.63. The best crop, which was raised on a lot of about 6 acres, gave a yield of 1,026 pounds per acre; the estimated cost was $649.86 per acre; the total value at $1.63 per pound, the average price obtained for this lot, was $1,672.38, giving a net profit of $1,022.52 per acre.

A great deal of interest has been felt, of course, as to the experi-

ence of the cigar manufacturers in handling this product, and the reports have been anxiously awaited. Very favorable notices have been published from time to time in the press and various trade journals, but in order to obtain direct and reliable information the Department addressed three of the largest cigar manufacturers in Hartford and vicinity, who it was known had purchased some of the stock at auction. In reply to these inquiries the following letters were received:

HARTFORD, CONN., *August 25, 1902.*

DEAR SIR: I beg to inclose you my foreman's report on shade-grown tobacco. (Mitchelson, 1901 crop.) The appearance of the crop in the sheds this year shows an improvement in color; there are more brown leaves, with less of the green cast so much in evidence last season. I hope the growers will make a special effort to raise shade-grown wrappers only on land that produces a sure burn. This type is only for wrappers, and a perfect burn is quite important.

Respectfully, yours, CHARLES SOBY.

Report to Charles Soby by E. M. Roszelle, foreman of factory, on test of shade-grown wrappers, Mitchelson crop, 1901.

Shade-grown wrappers, as tested under my supervision, will show some remarkable results as to yield of product and of the effect on quality of cigars by their use. By comparison with a like quantity of imported Sumatra wrappers as to yield in product, the difference in favor of the shade-grown wrappers is apparent to all.

Our test on one bale of shade-grown wrappers of 155 pounds net weight shows the enormous yield of 85,432 cigars, an average of 29$\frac{1}{5}$ ounces per thousand. The same stock, as prepared by the tobacco strippers for the workmen's tables, shows an average of 27$\frac{1}{4}$ ounces per thousand, which includes waste of all descriptions in the stripping room. Our tests on imported Sumatra wrappers of same weights show an average of 70,000 cigars to the bale, with greater loss in stem and wrappers in preparation.

In casing for the stripping room, the shade-grown wrappers take the water very nicely and show no bad effects, the wrappers being much easier handled by the caser than Sumatra. It does not become matted, but separates without any trouble.

The workmen find no difficulty in working the leaf, as no loss of time or product is caused by the use of shade-grown wrappers. The leaf is very elastic, and works well by comparison with other wrappers tested by us.

The quality of the shade wrappers is excellent, and blends very well with our binders and fillers. I am positive the cigars are improved in quality by its use. I find no trouble with the burn of the leaf in my daily inspection of the wrappers. I have failed to find a single leaf that does not burn perfectly.

As to color, they are not perfect in all respects. I find that about 91 per cent of the stock tested by us was good in color.

All things considered, the points in favor of the shade-grown wrappers may be summed up as follows:

First. Greater yield in product.

Second. Leaves are lighter in weight and color.

Third. Less waste and cost in preparation for workmen's tables.

Fourth. Less loss in weight of stems as compared with Sumatra wrappers.

Respectfully, yours,

E. M. ROSZELLE.

SUFFIELD, CONN., *September 4, 1902.*

DEAR SIR: It is but right I should advise you as to the working quality of the Connecticut shade-grown Sumatra tobacco, from which I purchased at the sale in Hartford, Conn., on May 1, 1902, 20 bales.

I have worked in my cigar factory since then quite a proportion of this tobacco, and I am more than pleased with the results. It is finer and better in every way (in color, texture, and flavor) than the imported Sumatra, and the wrapping qualities are enormous; 20 ounces will easily wrap 1,000 5-inch cigars. I am confident that when cigar manufacturers come to work this tobacco the demand will be far greater than the supply.

Very respectfully, yours, L. P. BISSELL.

HARTFORD, CONN., *September 1, 1902.*

DEAR SIR: We have been using the shade-grown tobacco, which we bought at the auction held in this city last May, to some extent all summer. We are using it on a

small "perfecto" cigar. It wraps with about 2 pounds to 1,000 cigars. The colors have improved a great deal since last spring. It burns well and tastes well. So far we have not had any complaints from any of our customers about the cigars with this wrapper. We should like it better if it had a little more body, because then it would stand the cold weather better.

Very truly, yours, LEICHKE & PLETCHER.

In another communication Messrs. Leichke & Pletcher report that they could wrap 1,000 of their 5-inch cigars with 1 pound 10 ounces of the leaf, while Mr. Bissell, of Suffield, reported that he was using 2 pounds of the shade-grown leaf to wrap 1,000 of his cigars, and that with a bale of wrappers weighing 140 pounds 102,000 cigars were wrapped. It can safely be said, therefore, that the leaf has successfully stood the test of the cigar manufacturer.

Even before the tobacco was ready for the market or the results of the sale announced preparations were made by the growers to largely increase the acreage. Although the commercial success of the investigations had been fully demonstrated, the industry was so important and involved such an expenditure of labor and capital that, at the earnest solicitation of the growers, the Department's experts were left in the Connecticut Valley for another year to advise with such of the growers as needed their assistance. At the present time the Department is advising and instructing in this way 38 growers in Connecticut and Massachusetts, cultivating 645 acres of shade tobacco. The efforts of the Department in this direction seem to be very highly appreciated.

The season has been distinctly unfavorable. There has been an unprecedented amount of rain, falling in very severe showers, and the season as a whole has been characterized by cool spells and especially cool nights. This has apparently not affected the crop materially, as it is the general belief that the crop at this time is better than that of last year. The season has also been one of unusually severe wind and hail storms. Considerable damage has been done to the outside crops in certain sections of the State, but no damage has been done to the shaded tobacco, as the cloth has protected the leaf from all injury from hail. The damage from wind has also been exceedingly light. The winds have been so strong in places that the posts have been lifted from the ground, but the damage to the tents has been exceedingly slight and there has been practically no injury to the crop.

As to the financial prospects for this year, the following estimate is based on the experience of last year: There are about 700 acres of tobacco under shade, which will produce about 1,000,000 pounds of cured tobacco, or 800,800 pounds of baled tobacco, exclusive of trash. The total cost, at $657.17 per acre—the average for last year—will amount to $460,019. The total value of the baled tobacco at $1.20 per pound, the average price obtained at the auction, will be $960,960. The net profit will be $500,941. It is believed, however, that the cost per acre will be considerably less than last year, and that the price per pound will be greater. The Department believes that this industry has been successfully placed upon a commercial basis, and that there will be a considerable increase in the crop grown next year. We have demonstrated our ability to produce a leaf which is desired by our people, and for which about $6,000,000 have annually been expended in foreign countries. The demand for this product has always been greater than the supply, and prices have been maintained in a remarkable manner. It may seem strange to some that manufacturers can afford to pay such prices for wrapper leaf, but even at

$3 a pound for leaf that will wrap at the rate of 2 pounds to 1,000 cigars, the cost of the wrapper is about six-tenths of a cent. Even at such prices the leaf can profitably be used on a 5-cent cigar. There is so little waste to the leaf, it yields so well in the manufacture of cigars, the color is so uniform, and the grading is so perfect that manufacturers find it actually cheaper to pay $3 a pound for such leaf than to buy domestic wrappers at an average of 20 cents a pound or selected domestic wrappers at from 50 to 60 cents.

SUMATRA TOBACCO IN LOCALITIES OTHER THAN CONNECTICUT.

Considerable interest has been shown, of course, in the possibility of extending the Sumatra tobacco industry to other localities and to other States. It was predicted, as a result of the soil survey of the Lancaster area, Pennsylvania, that the Sumatra tobacco could be successfully grown under shade on the narrow strip of Donegal gravelly loam bordering the Susquehanna River. Experiments carried on this year by the Pennsylvania experiment station, in cooperation with this Department, in growing Sumatra tobacco under shade on a small tract of about 1 acre appear to have demonstrated the correctness of this prediction. The crop has been harvested and, judging from the product in the curing shed, it is of good quality. It is not believed by the Department experts that equally successful results will be attained on other soils in this area.

In response to demands from one of the principal New York tobacco districts, a soil survey was made this season of the Big Flats area in the Chemung Valley, New York. As a result of this survey, it is not believed by the Department experts that any considerable success will attend the growing of Sumatra tobacco on the soils of that locality, with the exception of a very small area of not exceeding 10 acres, where an experiment has been actually carried on by a gentleman familiar with the soils of the Connecticut Valley, who selected this tract because it represents the type of land that is found in Connecticut.

A soil survey has also been made of a considerable area in the Janesville area, Wisconsin. Two experiments of growing Sumatra tobacco under shade have been tried there, and the results at the time of harvesting indicate a fair degree of success. The Department does not believe, however, that the product of the soils of the Janesville area will approach in quality or in value the product raised in the Connecticut Valley. It is not intended by this to imply that the leaf can not be successfully grown in the Wisconsin area, but from the information at present obtainable it does not seem that the product will be of equal value with that of the Connecticut Valley. The Department is still of the opinion that the conditions essential for the raising of a high grade of Sumatra tobacco are limited in extent and can be closely defined by the soil survey.

INVESTIGATIONS IN THE FILLER TOBACCO DISTRICTS.

The experiment of raising Cuban filler in Lancaster County, Pa., last year was not a success. It is believed, however, that this was due to a misunderstanding with the growers and a consequent lack of care and thoroughness in the cultivation and handling of the crop. While it was thought that these investigations should not have been interrupted or discouragement felt at the lack of success in this first attempt, it was impossible for financial reasons to maintain a party in Pennsylvania, as a promise had already been given to start the work in

Ohio. Accordingly, more careful plans were made, and a crop was grown on the upland soils of the Miami Valley, under the direct and immediate supervision of the Department's experts. This crop has just been harvested, and it is too early to determine the value of the product. From other crops that have been raised in the locality from imported Cuban seed, which have been fermented by our experts and thoroughly examined, it would appear that a desirable type of leaf, approaching very closely the imported Cuban leaf, can be produced. The quality of the leaf is not at present all that could be desired. There is something harsh about the aroma, but it is thought that this can be considerably toned down, if not entirely eliminated, by thorough methods of cultivation and fermentation.

The tobacco situation in Texas has been thoroughly studied, and it is thought that a desirable leaf will be produced there by careful methods of cultivation, fermentation, and assorting.

CONFERENCE OF TOBACCO EXPERTS.

A conference has recently been held in Washington by the tobacco experts of the Department to consider the general situation and to advise as to the methods to be pursued during next season, especially in Ohio and Texas. Arrangements have been made for experimentation during the coming crop season with good prospects of producing fine filler tobacco in these two States. Leaf has been grown that can not be distinguished from the imported Cuban when properly fermented.

SALARIES OF TOBACCO EXPERTS.

The demand for experts to carry on tobacco investigations has been so great that Mr. Floyd, although receiving as high a salary as, in justice to other officers of departments, it seemed possible to pay him, and who at the time was getting a larger salary than the Chief of the Bureau who was directing the work, was induced to leave by the offer of compensation about three times as great as he was receiving in the Department. Quite recently his successor has been approached in the same way by a corporation intending to operate in the Connecticut Valley, and it is likely that he will leave the Department to accept a much more remunerative position outside. Two years ago I had to note the loss to the Department of a gentleman who had made some important discoveries in tobacco fermentation, and who was called to Japan at a salary about four times as great as he was receiving in the Department.

It is gratifying to feel that the Department's experts are looked upon with such favor in the commercial world, but these experts are so difficult to obtain, and to train them requires so long a time, that the Department is very greatly embarrassed when they are thus removed because of lack of opportunity to pay them what their services are worth in commercial lines. As this work has been developed by the Department, it seems strange to think that the very success of the work is hindering, if it does not prevent, the successful extension of the investigations.

EXTENSION OF THE TOBACCO INVESTIGATIONS.

The tobacco investigations of the past two years have been carried on with three field parties, at a cost of about $5,000 each, or an aggregate of $15,000 per annum. On account of the great success of this work, and the extraordinary interest taken in its extension to other

areas, I recommended last year that the appropriations for the Bureau of Soils be increased so that the allotments for this work could be made sufficient for seven parties of tobacco experts. The appropriations as passed, however, did not allow of this increase, and the allotment this year has been the same as for last. The demands for the services of these tobacco experts have been very great, and I would recommend that three additional parties be organized for work in Pennsylvania, Wisconsin, and North Carolina. This will mean an increase of $15,000 in the allotment, making in all the sum of $30,000 for the tobacco investigations. I feel that the economic results of the work so far done, and the lines of work that are at present being developed, fully justify this recommendation. The reports from the Connecticut Valley alone indicate that nearly $1,000,000 worth of Sumatra tobacco will be grown in the State this year. This has largely increased the price of land; has furnished a market for thousands of chestnut posts from adjacent ridges which have lain idle and unproductive for years; has given employment in a healthful occupation and at remunerative wages to large numbers of men and women; has brought about the production of millions of square yards of cloth by the cloth manufacturers, and has opened up the possibility of an enormously profitable industry for the future. It would seem that this experiment alone would fully justify the increase in the allotment that is asked, but when it is stated that we expend annually $8,000,000 for filler tobacco which the experts of the Department believe can be produced in this country, it but adds to the justification of the request for the larger allotment for this work.

Drainage Investigations.

During the year an investigation was started as to the possibility and practicability of reclaiming the soils in the arid regions which have been injured by seepage water and the accumulation of alkali. In cooperation with the Utah experiment station and Mr. C. D. Swann, of Salt Lake City, who has donated land for the purpose and has paid a considerable portion of the field expenses, a tract of 40 acres of alkali land near Salt Lake City has been thoroughly underdrained with tile. This work has been under the immediate supervision of the Department experts, and the work of reclamation is to be under the joint charge of the Department and the Utah experiment station. It is too early yet to speak of the results of this work. It is being watched with the greatest interest by the people of that locality, and it is believed that if the investigation is a success ample capital will be forthcoming to carry on extensive operations in the reclamation of alkali tracts and the prevention of damage to irrigated lands from seepage waters. This work is under the immediate charge of Mr. W. H. Heileman.

Arrangements are being made for the carrying on of similar work at Fresno, Cal., and it is proposed to extend this work to a typical area in Montana and possibly in Arizona, to demonstrate to the people that these unfavorable conditions can be economically controlled. It is estimated that land values in the immediate vicinity of Salt Lake City will be increased at least $3,000,000, exclusive of the cost of reclamation, if they can be reclaimed from the alkali with which they are now impregnated, and it is believed that equally great benefits will result in other portions of the arid West.

In furtherance of this work, Mr. Thomas H. Means, of the Bureau

of Soils, has accompanied Mr. Thomás H. Kearney, of the Bureau of Plant Industry, on a trip to Algeria and Egypt to study the treatment of alkali lands, the use of alkaline waters in irrigation, the methods used in the reclamation from seepage water and alkali, and the crops adapted to alkali soils. This investigation has not yet been completed, but sufficient has been heard from the party to indicate that conditions even more serious than those existing in the arid regions of this country are under perfect control, and it is believed that the information thus gathered will be of great benefit to the people of Western America.

BUREAU OF CHEMISTRY.

Examination of Imported Food Products.

The Bureau of Chemistry has continued the examination of imported food products for the purpose of determining if they contain any added substances injurious to health. The Bureau has also collaborated with the Treasury Department in controlling the polarizations of imported sugars and in determining the character of certain other imported products in order to classify them for dutiable purposes. Investigations of the adulteration of food products is one of the important studies of this Bureau, and the work has been especially devoted during the past year to the adulterations of olive oils, with the object of securing an honest market for the olive oils of domestic manufacture which are compelled to compete with cheaper and adulterated oils.

Investigations of Forest Products.

Important investigations, in cooperation with the Bureau of Forestry, have been conducted by this Bureau in connection with economic forest products such as tannin, gums, rubbers, and wood pulps.

Laboratory Tests of Road Materials.

The road material laboratory of this Bureau, which was established in December, 1900, in cooperation with the Office of Public Road Inquiries, tests road materials of all descriptions, free of charge, for practical road builders throughout the country.

Those interested in the construction of a road have only to send samples of their available materials to this laboratory and have the road-making qualities of these materials determined. In the case of materials for macadam roads, the resistance of wear to rock, its cementing value, hardness, toughness, and absorptiveness are determined. After such tests are made it is possible to predict which material will give the best practical results under a given traffic.

Only practical road builders of much experience realize the large amount of money which can be wasted through an improper selection of material. There are generally several materials available in every locality, and the difficulty of selecting the most suitable for a particular road is evident. The only way a proper selection can be made within a reasonable time is by means of physical and chemical laboratory tests.

The laboratory is now equipped for the testing of road materials of every description, as well as cement and concrete for drains and highway bridges.

The large number of samples received from all parts of the country, including our island possessions, attest the value which practical road builders place upon these laboratory tests.

Investigations in the Sugar Laboratory.

Important investigations looking to improving the quantity and quality of table sirups have been made in the sugar laboratory, and critical studies have been undertaken of the influences tending to produce the maximum content of sugar in beets, melons, and other sugar-producing plants.

Studies of Insecticides.

Studies of the various insecticides in common use in agriculture have been conducted with the object of determining the value of their constituents. Since arsenious acid is one of the most common constituents of insecticides, an investigation has been commenced to determine the effect of this body upon the foliage of plants and to ascertain whether any of the arsenic thus applied for insecticidal purposes is found in the food products derived from the plants which have been thus treated.

Study of Environment of Chemical Composition of Cereals.

Extensive collaborative work has been instituted with many of the agricultural experiment stations for the study of the effect of environment on chemical composition of wheat and other cereals and to ascertain the most reliable methods for judging the quality of the soils from their chemical constitution.

Study of Waters used in Irrigation.

The study of the character of waters used in irrigation, especially in the growing of rice, has been begun, to determine the quantity of injurious salts which these waters may contain and the quantities of this water which may be safely used upon the fields.

Establishment of New Laboratories.

New laboratories have been established to study the effects of preservatives and other added substances upon the health of the consumer, with the view of determining the character and amount of such substances which may be safely used in such foods without injury to public health.

A contract laboratory has also been established for the purpose of ascertaining the quality and quantity of materials purchased for the Department of Agriculture and other Departments of the Government, and to establish specifications for such supplies, based on physical and chemical properties.

A drug laboratory has been established also to study the character, standard, and adulteration of drug products. The larger portion of the drugs in commerce are of agricultural and horticultural origin, and the necessity of securing purity and conformity to standards in articles of this kind is evident. Dangerous narcotics and poisonous substances should not be indiscriminately sold, and drugs intended for ordinary therapeutical purposes should conform to the standards laid down by competent authorities.

Work for Other Departments.

The Bureau of Chemistry is constantly increasing the services rendered to other Departments of the Government. This is especially true in respect of its collaborative work with the Treasury Department in controlling the polarizations of sugars, and in assisting the appraisers

in the classification of other imported articles where the rate of duty depends upon chemical and physical characters.

Extensive studies have also been conducted for the Post-Office Department in regard to the character of canceling inks and stamps used therewith. Similar investigations have been conducted for the Bureau of Engraving and Printing in regard to colors used for printing bank notes, bonds, and other Government securities.

All of this work is of a nature which is highly important to the public service, and is conducted largely on agricultural products.

DIVISION OF ENTOMOLOGY.

Work on Insects from Abroad.

THE SAN JOSE SCALE AND ITS ASIATIC LADYBIRD ENEMY.

In the report of last year attention was called to the exploration which was being conducted by the First Assistant Entomologist, Mr. Marlatt, in Japan and China, to discover, if possible, the native home of the San Jose scale (*Aspidiotus perniciosus*), and also to find native parasites and enemies which might be imported to control or at least check the damage which is done by this insect in the deciduous orchards of this country. Mr. Marlatt's exploration of Japan demonstrated that the San Jose scale is not a native of that country, as many of our entomologists had supposed, but, on the contrary, that it had come to Japan comparatively recently on imported nursery stock, and been thus spread somewhat generally over the islands of the Japanese Empire. Subsequent to the time covered by the report for 1901, viz, in the late summer and fall of that year, Mr. Marlatt extended his explorations to China, examining the coast region from Shanghai northward to Pekin. The evidence from native fruits and wild plants in the region about Pekin and south of the Great Wall established very clearly that the original home of the San Jose scale was in this region.

In brief, this scale insect was found on wild haw apples, native crab apples, and native pears grown in the region indicated where no foreign fruit stock had ever been introduced. Furthermore, it was found in scattering numbers everywhere, just as one would expect in the native home of a pest of this sort where it is normally kept in check by natural enemies. There can be no doubt that at last its original home has been located. It was probably brought to America many years ago on imported Chinese flowering peaches or some other ornamental or flowering shrub from this region, having first appeared in the gardens of a great importer of ornamental and other plants in San Jose, Cal. A very interesting fact in connection with this discovery was the finding in this same region of a ladybird which preys on it naturally and seems to be the principal agent in preventing its often becoming very abundant and injurious. This ladybird (*Chilocorus similis*), a European and Asiatic species, in China feeds naturally on the San Jose scale and related forms, as also on the white peach scale, a very troublesome pest, which has recently gained foothold in our Eastern and Southern States. Several shipments of this beetle were made by Mr. Marlatt, some from Japan and some from China. Unfortunately, all perished but two, this mortality resulting from the long confinement of the six or seven weeks' trip from Asia and the unfavorable conditions under which they were kept in Washington during the winter.

From the two surviving individuals more than 2,000 beetles and

larvæ are now on scale-covered trees on the Department grounds. In addition to these, shipments of some thousand beetles have been already made to other points in the East, a number of experiment station entomologists having expressed a desire to assist in the work of propagating, distributing, and establishing this useful ladybird. This importation promises most flattering results at present. It is, however, still an experiment, and what the ultimate benefit will be can only be determined after a two or three years' test. We hope to establish this ladybird in this country and to get from it some of the good results, at least, which it evidently accomplishes in China and Japan. It probably will not render it unnecessary in the future to occasionally spray or otherwise treat infested trees in commercial orchards, but it probably will be of very great assistance in keeping in check the San Jose scale in the thousands of gardens and small orchards of individuals who have no commercial interest at stake and who would not, ordinarily, take any means to keep this scale insect from multiplying on their trees, thus forming centers for contagion.

IMPORTATIONS OF OTHER BENEFICIAL INSECTS.

The preliminary attempts to introduce the European enemies of the gipsy moth have been continued. The difficulties attending the importation of the predaceous beetles from Europe to America are considerable, and to get them established in this country will demand the careful cooperation of agents or interested individuals on the other side.

The black scale of the orange is the most destructive, perhaps, of all the orange pests in California, and the South African parasite of this scale insect, which we have been endeavoring to establish in California for the last year or two, still gives promise of ultimately becoming a fixture and doing the good service in our Western orange districts which it now does in South Africa and in Italy. The history of this importation was given in my report of last year. A recent letter from Mr. Alexander Craw, who is looking out for this experiment in California, reports that the parasite is breeding abundantly. With a beginning of only two female insects kept in captivity, he had sent out to different localities up to July of this year (1902) 25 colonies.

The very important European parasite of the larger scale insects such as the Lecaniums and mealy bugs (*Erastria scitula*) seems on the way to be successfully established in California. It is believed that the introduction of this insect into our citrus and olive districts will be of the greatest advantage to the growers of these fruits. With the cooperation of Mr. Craw, the horticultural quarantine officer, and Mr. Ehrhorn, of Santa Clara, these insects have already been liberated in Santa Clara, Los Angeles, and Niles, Cal., and the outcome of this effort at the introduction of a useful insect will be watched with interest, and the utmost care will be taken to bring it to a successful issue.

Another foreign insect promising great usefulness in a different direction, imported during the past year, is the European ladybird (*Coccinella septempunctata*) sent from Hungary through the kindness of Professor Sajo. These ladybirds feed on plant lice, and should be an efficient aid in controlling the destructive insects of this class which infest cotton, peas, melons, and other vegetables, and the fruits. Some of these insects have been sent to Mr. Craw, in California, where they give promise of becoming established; others to various Eastern experiment station entomologists, and they have also been colonized

in the District of Columbia. Another ladybird (*Leis conformis*), a plant-lice feeder also, was imported from Italy and liberated in California. A further importation of this species may be necessary to effect its establishment here.

This entomological work of an international character has not been altogether one-sided. In other words, while we have been importing foreign insects and have been receiving a good deal of gratuitous assistance by entomologists abroad in this work, we have paid our debts, to a certain extent, by sending to foreign countries some of our beneficial insects. The extraordinary success in preventing damage from the white scale, once a great orange pest in California, by the introduction of the Australian ladybird, has been duplicated, as made evident in former reports, in many foreign lands, notably South Africa, Portugal, and Egypt. During the last year colonies were sent from California, at our request, to Dr. Antonio Berlese, Portici, Italy, where this same white scale had established itself. Recent reports indicate that this exportation has proved to be another of the series of successes which has attended this insect wherever it has been sent to work against its notable scale-insect host. A colony of this ladybird has recently been sent, by request of the local board of agriculture, to Papeiti, Society Islands. We have also had sent, through the kindness of Mr. Craw, various beneficial ladybirds to the Bermuda Islands to assist in keeping in check the noxious scale insects occurring on those islands.

The South African Grasshopper Fungus.

The report of last year noted the beginning of an experiment to determine the effectiveness of the African grasshopper fungus as a means of destroying various forms of destructive locusts. The experiment has been continued the present year and much extended, the intention being to give this fungus a thorough and practical test to demonstrate whether it can really be counted on as a means of controlling the locust or not. The number of experimenters last year during the entire season was 223. During the summer of 1902 cultures of the fungus were sent to nearly 1,000 individuals, not including the perhaps even greater number of cultures which have been locally prepared by various individuals, and especially by Prof. C. P. Gillette, of the Colorado State Agricultural College, who has taken charge of the culture preparations and their distribution in his State. These cultures have been sent out to 25 different States and Territories. Results have not yet been tabulated, but some successes have been reported. It now seems probable that very great reliance can not be placed on this fungous disease. Either it does not work with our grasshoppers as readily as it does with the South African locust or our climate makes our species of grasshopper more resistant or the fungus less operative.

The Fig Fertilizing Insect.

As a further report of progress on the introduction and establishment of the fig-fertilizing insect in California referred to in previous reports and especially summarized in the report for 1901, it may be said for the year 1902 that thousands of figs containing the insects successfully withstood the winter climate of California, and an unlimited amount of fig insects was available at the proper time for caprification in the spring of 1902, resulting in the production of some 50 tons of

Smyrna figs in the sole commercial orchard in existence at present, that of Mr. George C. Roeding, at Fresno. It was further found that the fig insect successfully hibernates at Niles, Cal., and there is now no longer any danger of its dying out. In other words, the entomological problem of Smyrna fig culture in America is solved, and what remains to be done belongs rather to the domain of horticulture, namely, the introduction of more caprifig trees, improvement in the methods of curing and drying the fruit, and the determination of the regions throughout the arid West suitable to the industry. The practical success of Smyrna fig culture in California is now only a matter of time. In a very few years Smyrna fig orchards will be in bearing in many places in California and doubtless in other Western States where climatic conditions are favorable.

As stated in the report for 1901, Mr. Roeding spent nearly a year in Smyrna studying the methods of fig culture in that country under a commission from this Department. Much valuable data was obtained, for the most part appertaining to the horticultural side of the problem. The future of this industry, which promises to be one of the great ones of the arid region of the West, becomes more promising every year.

Work on the Mexican Cotton Boll Weevil.

The work on the Mexican cotton boll weevil reported in 1901 has been continued, and has the present season been given a very practical status by means of the specific appropriation by Congress for the purpose of $20,000. A field experiment is being conducted on two cotton plantations, one of 200 and the other of 125 acres, under the control and direct management of the Entomologist, to demonstrate that by proper methods the damage from the boll weevil can be so reduced as not to be a serious menace to the production of this important staple in the region in Texas already invaded by the weevil.

In spite of the delayed beginning this year, owing to the late date at which the appropriation was available, the entomological side of this field experiment has been thoroughly successful, and the weevil has been practically eliminated from the plantations under Departmental control. The cotton season, however, in Texas has been the most disastrous one climatically in twenty-five years, and this will prevent the cotton yield on these plantations coming up to the average, the lessened yield, however, in no wise being chargeable to the boll weevil. It is urged that the means for continuing this investigation be provided, as it is one of the very greatest importance for the whole cotton industry of the South. There can be very little doubt but that ultimately the Mexican boll weevil will spread to the adjoining State of Louisiana, and thence across the cotton belt east of the Mississippi, and is capable of becoming one of the most destructive insects in America. If, on the other hand, the Department can demonstrate by practical field work that the weevil can be controlled, as indicated by the preliminary experiment this year, it will have the effect of influencing planters generally, in Texas and elsewhere, to adopt the same methods, and thus avoid much of the loss which this insect threatens.

In this connection, reference may be made to the Egyptian cotton which, by newspaper report and otherwise, has been somewhat exploited as immune to the boll weevil. This misconception is capable of doing harm, inasmuch as the Egyptian cotton is rather more subject to weevil damage than the variety of cotton ordinarily grown in Texas. In a field of Egyptian cotton near San Antonio practically every

square was punctured by December 12, and the weevils had begun to attack the bolls, half of which had at that date been destroyed. The fact that Egyptian cotton seems to be later in maturing than the smaller American plant causes it to be much more liable to damage by the boll weevil. The same conditions with Egyptian cotton were also noted on another plantation.

In the fall of 1902, after the close of the active field work of the season, the agent in charge made some very desirable explorations in Mexico, more especially to investigate the subject of natural enemies. Important biological and life history studies have been prosecuted in Texas and the present range of the insect has been carefully mapped.

Work on the Codling Moth in the Northwest.

The work done on the codling moth in the Northwest has been continued with very satisfactory results. A detailed report of this work has been published. The work the present year has been of a very practical character, a successful orchard demonstration having been conducted which showed that it is possible to prevent much of the damage which is now annually suffered from the codling moth.

Work on Insects Damaging Forests.

During the first half of the year several important investigations were made of forest insect depredations by Dr. A. D. Hopkins, of the West Virginia experiment station, who was employed at the request of Mr. Gifford Pinchot, of the Bureau of Forestry, as a temporary agent of the Division of Entomology for the purpose. Great loss of pine timber, to the amount of more than 600,000,000 feet (board measure) in the Black Hills Forest Reserve, has resulted from the work of a bark-beetle mining under the bark of living trees. Numerous facts have been determined relative to the life history of this insect, and it has been possible to detail practical methods, the adoption of which will largely decrease future losses. A report of this investigation has been published.

Another investigation was of hickory and other forest trees near Geneseo, N. Y. The hickories had been killed by a bark beetle, the damage having already gone beyond repair for most of the region invaded. Had an earlier report of the difficulty been made to the office, a prompt application of known methods of control would have prevented this loss. A special report of this investigation will soon be published. The damage occasioned by this hickory bark beetle seems to be quite general throughout the Northern United States, and will receive considerable attention in the future, especially now that Dr. Hopkins has been regularly appointed to the Division of Entomology as expert in forestry insects. A study of the insect enemies of Eastern, Southern, and Western pine forests has been begun to determine, if possible, the primary causes of the serious insect damage now being done to pine timber of western North and South Carolina, northern Georgia, southern Florida, the white pine or silver pine of the Pacific slope, the Monterey pine, California, and the pines of Arizona and Colorado. The regions designated have been given a preliminary survey to determine existing conditions, and it is expected that by the close of the next fiscal year it will be possible to have a report ready for publication on the principal pine insects of North America, which will include brief popular descriptions of the more

important insects, with illustrations, and recommendations for preventing losses.

Work on Scale Insects.

The important work of the year on scale insects has been the investigation of the San Jose scale in China and Japan, referred to under "Work on insects from abroad." The experimental work on the San Jose scale at home has been continued, and a circular (No. 42) describing the methods of controlling this insect has been revised to include the results of the latest information on methods of treatment.

The Division of Entomology of this Department is looked upon as the chief source of information upon scale insects, few of the experiment stations having collections or literature sufficient to enable the determination of specimens; hence much work is done every year in determining material for station entomologists and for private individuals throughout the country. In addition, many large collections of scale insects have been received for study and determination from foreign countries, notably from Australia, New Zealand, the Bermudas, and Italy.

In the course of the trip of exploration made by Mr. Marlatt in Japan and China, Java, and other countries in the Orient, a particular study was made of the scale enemies of citrus and other fruit trees, and large collections of this class of pests were brought home from the countries visited. The knowledge gained from this study will be of great practical importance. It will acquaint us with the scale pests of these countries, which are being brought into closer commercial relations with the United States, a knowledge which is desirable because these insects are more apt in the future than in the past to reach our shores through importations of fruit trees and ornamental stock. The scale insects of foreign countries are perhaps the most important pests to be considered in all quarantine and other operations looking to the protection of our growers from foreign invasions, since these insects live for the most part attached to the bark of trees and are much more apt to be brought in with plants than are other insects.

Insects Injurious to Shade Trees.

Many complaints of insects affecting shade trees have been received in recent years, and among these are several important foreign species, which have been under investigation during the year.

Insects Injurious to Truck Crops.

The studies already under way on destructive insects affecting truck crops have been actively followed up, and an extensive report on the principal insects that have recently been injurious to vegetable crops has recently been issued. A number of insects injurious to leguminous food crops received considerable attention, and the new facts discovered in the life histories of some of them are of value in suggesting means of control.

Work on Insects Injurious to Stored Products.

Certain insects of this class are increasing their ravages. The Mediterranean flour moth, which is the most troublesome of all insects that are harmful in flouring mills, was reported as injurious in mills in new localities in California, and in Michigan, Wisconsin, and Minnesota. The Angoumois grain moth has also increased in injuriousness in a number of States, particularly northward and in California.

The cigarette beetle has been very destructive during the past season. Thorough investigations were conducted with a view to find a remedy for this pest, and much of value was learned and published.

An exotic cabinet beetle did much injury to silk in New Jersey and to domestic tanned leather in New York City, its introduction being traceable to the introduction of foreign hides. In the treatment of the insects which affect stored products, recent experiments with hydrocyanic-acid gas indicate that this remedy may, in course of time, be found more valuable than the bisulphide of carbon usually employed in the treatment of many such insects.

Work on Insects in their Direct Relation to the Health of Man.

Insects as conveyers of disease to human beings have been the subject of special research by the Entomologist for the past three years. A popular article on this topic was published in the Yearbook for 1901, and has since been reprinted in more popular form. During the past summer many inquiries have been received requesting information and advice on the subject of mosquito and fly control, and these have been answered by the publication in question and by specific advice. This investigation is being actively prosecuted; the field is a very large one and of the greatest importance. While perhaps the principal insects responsible for the transmission of disease have received study, there remains very much yet to be learned of them, and, furthermore, the Entomologist is in frequent receipt of new material from this and other countries, and is constantly discovering new facts bearing on this general problem.

Unclassified Work on Injurious Insects.

During the fiscal year investigations were taken up on supposed insect damage to cocoanut and other palms in Cuba, Florida, and in British Honduras. An article on the principal insects which act as disseminators of the trouble locally termed "fever," and due to a fungous disease, includes suggestions for methods of prevention of the dissemination of the disease.

Insect Determinations.

An important line of work is the identification and maintenance of records of the habits of injurious insects received from correspondents, field agents, and others to serve as a basis for determining the best means of controlling them. During the fiscal year 226 species not hitherto studied at this Department received more or less attention, and the catalogue number of biological series thus studied now reaches 9,667.

The time of two expert assistant entomologists and several minor assistants and aids is devoted to the preparation of material for permanent storage in the United States National Museum, for exchange with other institutions, and for illustration and description.

Experimental Work with Insecticides.

During the year a considerable number of experiments with insecticides and other methods of controlling insect depredations have been conducted. A great many insecticide substances are constantly being advertised, and many of them are sent to the Entomologist for experimental examination and test either from purchasers or the manufacturers. Most of these are of very little value, or are combinations of old and well-known insecticide substances, sold, however, as a rule,

under their new form at many times their real cost. The assistance of the Chemist has been invoked to determine the composition of these substances, and he has recently established a special section for insecticide analysis and investigation in cooperation with the Division of Entomology.

To determine the feasibility of eradicating household insects by fumigation with hydrocyanic-acid gas several valuable experimental operations have been conducted, with the result of the establishment of the complete practicability of disinfecting houses by this means. This poisonous gas can be used without risk to human life if the operation is carried on with proper precautions, but no one is advised to undertake it without having fully acquainted himself with the steps in the process as indicated in Circular No. 46 of the Entomologist's office.

Silk Investigations.

The silk investigations authorized by the last Congress have been placed in the charge of the Entomologist. Miss Henrietta A. Kelly has been employed as special agent in silk culture in the South, and is charged with the preparation of a manual of instructions which it is expected will be ready for publication and distribution this fall. She will also look over the ground and select suitable locations for model silk plantations and rearing establishments which may serve as schools of instruction where interested persons and others may come and acquire familiarity with all the steps in the care of caterpillars and the handling of cocoons. The Entomologist, Dr. Howard, during the summer made a careful examination of the silk industry of southern France and of Italy, studying especially the methods of reeling silk and silk manufacturing establishments, mulberry culture, and breeding methods. He has also arranged for the purchase of "seed" or silkworm eggs which can be relied upon as free from disease, and has negotiated for the importation of desirable mulberry stock. It is the intention to follow up this investigation by establishing experimental stations in the South, by cooperative work with some of the agricultural experiment stations which have expressed the wish to assist us in the investigation of silk culture, and also to establish at some suitable point a practicable reeling plant so that the silk cocoons produced in small quantities may be purchased and reeled and the product marketed.

Apicultural Investigations.

In apiculture the work has included an importation of select breeding queens from Italy and smaller importations from Austria and Cyprus. These were forwarded to experiment stations and to bee raisers in different sections of the country. Very favorable reports from these queens have been received, notably from southern California, where, it was stated, while black bees were doing nothing, the Cyprians from the Department importation gathered a fair crop, double the yield also of the best Italians. Various crosses were made between these races and some promising strains secured, one result being that the irritability of some excellent honey gatherers can be modified by using males of gentler races in the crosses.

DIVISION OF BIOLOGICAL SURVEY.

The Biological Survey is charged by Congress with three distinct lines of investigation, each of which is organized as an independent section of coordinate value with the ordinary Departmental division.

The first, or Biological Survey proper, studies the geographical distribution of mammals, birds, and plants with reference to the climatic factors governing distribution, and from this study prepares maps showing the boundaries of the natural life zones and crop belts of the country; the second, or Section of Economic Ornithology, studies the food and food habits of birds with relation to agriculture and horticulture; the third deals with matters of game preservation and introduction.

Biological Survey.

California and Texas, owing to their great size, the diversity and commercial value of their agricultural products, and their promise of far greater development in future, have unusual claims on the Biological Survey. In California the work is peculiarly difficult by reason of the extraordinary diversity of the topography and climatic conditions. Not only are there torrid valleys below the level of the sea, and alpine summits towering to elevations above the limit of plant growth; there are also areas of excessive humidity, of frequent fogs and heavy rainfall, and areas of excessive aridity, hotter and drier than the Sahara, where perpetual sunshine is the rule and years sometimes pass without rain.

Owing to the trend of the principal mountains and the influence of the coast fogs, the zones run in the main north and south instead of east and west. Some of the large interior valleys, notably the Salinas, act as flues through which a great volume of fog flows daily at certain seasons, lowering the temperature and increasing the humidity for a distance of 75 miles or more. These great rivers of fog cut off the sun, lower the temperature, and increase the humidity, and by overflowing through canyons and side valleys also reach and exert their influence in numerous tributary valleys and basins, some of which lie between the main fog river and the coast. In these cases the usual conditions are reversed, for ordinarily the valleys of the coast ranges in retreating from the sea toward the interior receive less and less fog and more and more heat and sunshine. Each valley and each mountain slope therefore has its own climatic individuality and its own capacity or adaptability for particular agricultural and horticultural crops. Some are cool enough for apples, cherries, and the sugar beet; others warm enough for almonds, raisin grapes, and citrus fruits. And in the case of some of those in which the same crops may be cultivated with equal success, these crops mature at widely different dates. Thus oranges ripen in southern California from January to April; on the Santa Barbara plain, in July and August; at Oroville, in November and December. Similarly, peaches mature at different points in northern California from May to September, and in Los Angeles as late as November. Cherries are ready for market in Vaca Valley in March and April, while in neighboring valleys they do not ripen until May and June. The great commercial importance of these differences in time of ripening of fruits is obvious.

The native fauna and flora of a region afford a suggestion as to its climatic peculiarities and agricultural possibilities, assisting one to conclude what farm crops and varieties of fruit will or will not be likely to succeed in a particular place. The Biological Survey is making a critical study of this subject, and is engaged in the preparation of maps showing the natural distribution of the faunal and floral areas and consequent courses of the crop belts, and is also preparing lists of the particular kinds and varieties of crops and fruits likely to succeed in each.

The labor of tracing the zone boundaries in California is one of infinite detail, and is rendered still more difficult by the absence of accurate topographic base maps, except of the areas already mapped by the United States Geological Survey.

In addition to the work in California and Texas, some field work has been done in Montana, the Dakotas, Nebraska, Kansas, Indian Territory, New Mexico, Mexico, and Canada.

THE PRAIRIE DOG SCOURGE.

The extension of ranching on the Great Plains has led to serious, widespread, and reiterated complaints of steadily increasing losses from the depredations of prairie dogs. The increase in these pests is the natural result of the destruction of their enemies, chiefly coyotes and the larger hawks. Assistants were sent to various points in the afflicted area, from Montana to Texas, and much information was collected. As a result a circular of directions for the destruction of prairie dogs has been published, and an article on the subject was contributed to the Yearbook for 1901.

SECTION OF ECONOMIC ORNITHOLOGY.

During the year field work on the food habits of birds has been carried on in California and Maryland, and the stomachs of considerably more than 2,000 birds have been examined in the laboratory. Of these, 1,000 were of the game birds, 500 of sparrows, and the remainder distributed among other groups of economic value. A bulletin on the food of sparrows has been published, one on the food of game birds is well advanced, and one including the results of an extended economic study of birds on a Maryland farm has gone to press.

For many years California fruit growers have complained of the destruction of buds and fruit by birds. In order to gain definite knowledge on this subject, the chief of the section was sent to California, where he spent several months studying the food habits of birds in the great fruit-growing districts. Besides observing the food habits and collecting the stomachs of birds killed in the fruit trees, he noted and collected the kinds of wild fruits and seeds, and also the insects found in the immediate neighborhood of the orchards, for aid in identifying the stomach contents of the birds.

SECTION OF GAME PROTECTION AND PRESERVATION.

Work under the Lacey Act has been continued along three principal lines: (1) Publication of information on game protection; (2) improvement in the inspection service guarding the importation of foreign birds and mammals; (3) cooperation in restricting illegal interstate shipment of game.

Compilations and synopses of game laws have been issued and widely distributed, and are in constant demand. Among the most popular and useful of these are digests of the game laws and of the laws protecting nongame birds for the current year. An annual directory of State officials and organizations dealing with matters of game protection was also published.

During the year 287 permits were issued for the entry of about 200 mammals and 50,000 birds. The imported birds may be classed under two heads—game birds introduced for propagation and birds bought to supply the trade in cage birds. The latter greatly exceed the former in number. The inspection service, which now includes the

principal ports of entry of both coasts, and also Honolulu, Hawaii, is now maintained by fees paid by the importers. Importers complain of this, and the Department would be glad to place the inspection service on a permanent basis should Congress make the necessary appropriation. By strict economy the service could be maintained at the three most important ports of entry at a total cost of $1,000 per annum.

DIVISION OF STATISTICS.

The work of the Division of Statistics has been continued on the usual lines. With a view to further improving its crop-reporting service two additional field agents have been appointed, and the statistical expert who has for some years had charge of the crop statistics of foreign countries competing with the United States has been sent to London, England, where he is in closer touch with the statistical offices of the different European Governments, whose reports, along with the most authoritative commercial intelligence of interest to American agriculturists, he transmits to Washington by mail or cable from time to time.

In cooperation with the State Agricultural College of Minnesota a statistical investigation is being conducted by the Division of Statistics into methods of farming, the results of which will have an important bearing on such questions as the relative profitableness of crops, the economical utilization of farm labor, etc.

The work of this Division will shortly form the subject of a special report to Congress.

OFFICE OF EXPERIMENT STATIONS.

Development of the Work of the Office.

The functions of the Office of Experiment Stations have been enlarged in several directions during the past year, and the enterprises previously in its charge have become more extensive. Especial efforts have been made to aid the movement for the strengthening of agricultural education and research through the more definite formulation of agricultural science and the more thorough training of agricultural experts. For this purpose the work of this Office, in connection with the Graduate School of Agriculture, as described elsewhere in this report, has proved to be unusually successful and effective. Attempts have also been made to call the attention of the agricultural public and the managers of educational systems to the great desirability of making agricultural subjects a part of the curriculum of secondary and elementary schools. The development of the farmers' institutes as effective agencies for the dissemination of the results of the work of this Department and the experiment stations has also received attention. The agricultural experiment stations under the direct management of this Office in Alaska, Hawaii, and Porto Rico have been put upon a firm basis, and much progress has been made in developing useful lines of work in these regions.

The Office has been brought into closer relations with the institutions for agricultural research in foreign countries through work involved in the preparation of a bulletin setting forth the organization, resources, and lines of work of these institutions. By this means our knowledge of these foreign institutions has been greatly broadened, and it will be more feasible hereafter to secure definite information regarding their work which will be useful to similar institutions in this country. Both the legal and engineering features of the irri-

gation investigations have been enlarged, and a beginning has been made of investigations in other lines of agricultural engineering which have hitherto been neglected by this Department. Improvements have been made in the apparatus and methods for nutrition investigations. The results of these investigations have been more effectively brought to the attention of teachers of physiology and domestic science, and beginnings have been made of what it is hoped may develop a systematic study of dietaries in public institutions.

With the expansion of its work the amount of useful material prepared for publication in this Office has materially increased. Special efforts have been made during the past year to publish this material in forms which will contribute to its effective and economical distribution. The performance of duties growing out of the relations of the Department with the Civil Service Commission has also involved considerable work. With the constant and rapid growth of the system of agricultural education and research in this and other countries the general business of the Office in its relations with outside institutions is necessarily enlarged from year to year.

Progress of the Experiment Stations.

The feature of the progress of agricultural institutions in this country which has attracted most attention during the past year is the rapid increase in the public interest in these institutions. This is shown in the increase in the number of students in agricultural colleges and schools, in the larger attendance at the farmers' institutes, in the enlarged correspondence and mailing lists of the stations, in the increased demand for trained workers in agricultural and other business enterprises requiring scientific and expert knowledge and skill for their most successful management, and in the wider space given to agricultural education and research in agricultural and other journals.

During the year a number of new institutions for investigations in agriculture have been established in different States. The State legislatures have continued to be very liberal with the agricultural colleges and experiment stations. Over half a million dollars annually are now contributed by the States to the maintenance of the experiment stations.

Evidences of the influence of station work in improving agricultural practice and benefiting the farming interests of the country continue to multiply. This influence is felt in all of the various phases of agricultural operations. It is possible here to briefly refer to only a few recent examples of the practical benefits which are being derived from investigations by the experiment stations.

The origination and introduction of improved varieties of cereals through the agency of the stations of the grain-growing region, cooperating with this Department, is resulting in a vast increase of the grain-producing capacity of the country. As an illustration of this it may be cited that a variety of oats imported by the Department and tested and improved by the Wisconsin station, among others, has been widely distributed and grown, with results which indicate that its general introduction will be followed by an average increase of yield which may be safely estimated at from 3 to 5 bushels per acre. As the acreage of oats in Wisconsin alone in 1901 was, according to our statistician, 2,290,288, producing 66,647,381 bushels, worth $25,992,479, this would mean a gain to the farmers of Wisconsin annually of from $2,400,000 to $4,400,000 on the oat crop alone.

Marked improvement in the yield and quality of wheat in the Northwestern States is resulting from the distribution of improved varieties originated by the Minnesota station. One of the results of the work of the Illinois station on the breeding of corn has been the formation of the Illinois Seed Corn Breeders' Association, a chartered organization, with a limited membership of reputable and well-known corn growers, pledged to select and grow their seed corn according to definite rules formulated by the station and to sell only their own crop. The success of this enterprise has been phenomenal. All of the available supply of the improved seed is rapidly disposed of to farmers and much of it is engaged in advance. The work of this station on corn is proving to be far-reaching in its results, not only in improving the general quality of seed corn, but in inducing practical men to undertake breeding for special qualities—for protein, for oil, or for starch—which the station has demonstrated to be entirely feasible. The influence of station investigations is also being widely exerted in the grain-growing region in the introduction of rotations to conserve soil fertility in place of the exhaustive system of continuous grain cropping heretofore generally followed.

The beneficial effects of the work of the stations in the older States on fertilizers are becoming every year more apparent in the economical purchase and intelligent use of fertilizers by farmers. For example, as a direct result of the investigations and advice of the New Jersey station, organizations of farmers have been formed in the truck-growing districts of that State for the purchase of unmixed fertilizing materials, thus effecting a saving of from 25 to 40 per cent in the cost of their fertilizers, and at the same time securing better results as regards earliness, yield, and quality of product.

The recent introduction into a number of States of a system of inspection by the stations of feeding stuffs, similar to that which has been in force for some time for fertilizers, furnishes a very effective means of protecting farmers against fraud and of inculcating correct ideas regarding feeds and feeding. It is encouraging to note that in many States farmers are now following very closely the advice of the stations regarding the purchase of concentrated feeds and the balancing of rations made from home-grown products.

The rapid extension of the rational use of silage and the very general adoption of the round form of silo is directly traceable to experiment station influence.

Through the efforts of the Department and the stations, the application of insecticides and fungicides as means of protection against injurious insects and plant diseases has become almost universal, and the benefits and profits resulting from the practice are no longer questioned. Striking evidence of the readiness with which farmers and fruit growers will now adopt promising means of plant protection is furnished by the fact that the method of formaldehyde treatment of smut of oats, proposed by one of the stations, was almost immediately put into use by over 25,000 farmers in the State of Wisconsin alone, with the prospect that the number using the method will be vastly increased the next year. As the estimated loss from oat smut in Wisconsin varies from $3,000,000 to $7,000,000 annually, according to the season and other conditions, the value of an effective means of prevention of the disease can be readily estimated.

The Utah station has achieved notable success in its study of the extent to which dry farming, that is, farming on lands in the arid

region which can not be irrigated, may be practiced with profit and the conditions necessary to success. This work is bearing fruit in the rapid extension on a safe basis of what has heretofore been a very precarious system.

So rapidly has the demand for the services of agricultural experts spread in different directions that the workers in this service have in many instances been overworked, or, at least, have been forced to dissipate their energies in attempts to cover too many fields. There is, therefore, a most urgent necessity that the number of workers in our agricultural institutions should be increased so as to permit proper specialization of work. The station investigators must be relieved of teaching, lecturing at farmers' institutes, and other services, which, while important in themselves, distract their attention, dissipate their energies, and seriously hinder the progress of effective investigations.

It will be of little use to construct expensive laboratories and equip them with elaborate apparatus unless they are manned with first-class investigators. There is nothing new in this proposition, but the progress of agricultural institutions in this country in recent years makes it imperative that the work of the experiment stations and of this Department as the source of new knowledge on agricultural problems should be raised to the highest grade and kept there. The wider the work of the agricultural colleges, schools, farmers' institutes, and other agencies for the education of our rural population becomes the more important is it that the institutions of research in agriculture should be the best that human wisdom can devise. It is now necessary to insist on this more strongly than ever before, and it will be necessary to reiterate it until the managers of agricultural institutions and the friends of agricultural progress accept this principle in practice as well as in theory. Under present conditions a large number of the experiment-station workers are attempting too many different kinds of work, and the progress of the station is seriously hindered from this cause.

One result of the lack of a sufficient number of well-trained and experienced workers in our agricultural institutions is that the best men are constantly being shifted from one institution to another or are departing to outside enterprises offering larger salaries and other attractions. The past year has witnessed an unusually large number of such changes in the personnel of the experiment stations. This is a very serious matter, since the time element in the conduct of agricultural investigations is an important one. Until the tenure of office in our stations is much more stable than at present we must expect that there will be much waste of work and funds in incomplete investigations due to the frequent shifting of the officers in charge. There is also need of increased funds for the general expenses connected with agricultural investigations.

Cooperation of the Stations with the Department.

During the past year many cooperative enterprises between the different Bureaus and Divisions of this Department and the experiment stations have been continued and contracts have been made for a considerable number of new investigations on this plan. In order to more clearly define the conditions under which such cooperative arrangements should be made a plan was formulated for conducting this work and transmitted to the directors of stations as well as to the chiefs of Bureaus and Divisions of the Department. This has cleared away some

difficulties hitherto attending arrangements with the stations, and especially has defined the responsibilities of both the Department and stations in such enterprises.

The work undertaken conjointly with the stations is of the most varied character, but under the system devised there is no friction, and it is believed that much good will result to both the Department and the stations by this close union of interests. In all cases the general policy is to bring about a definite and clear understanding regarding the responsibilities of the Department and the stations, and when this is accomplished the carrying out of the details is a comparatively simple matter. The Department is not concerned with local State problems, but there are questions not bounded by State lines which the Department can take up, and which, with the cooperation of one or more stations, should be earnestly investigated. In this way the Department becomes the medium for the combining of interests in a way that will be helpful to all.

Graduate School of Agriculture.

A new enterprise in agricultural education has been inaugurated by the establishment of the Graduate School of Agriculture, which held a four weeks' session during the month of July, 1902, at the Ohio State University, Columbus, Ohio. The plan for this school was originated by Prof. Thomas F. Hunt, dean of the college of agriculture and domestic science of the Ohio State University, the purpose being to establish a school for advanced students of agriculture at which leading teachers and investigators of the agricultural colleges and experiment stations and this Department should present in some regular way summaries of the recent progress of agricultural science, illustrate improved methods of teaching agricultural subjects, and afford a somewhat extended opportunity for the discussion of live topics drawn from the rapidly advancing science of agriculture. This idea received the cordial support of President Thompson of the Ohio State University, and on the recommendations of these two men the board of trustees of the university voted to establish such a school and generously made provision for the financial support of its first session.

The Association of American Agricultural Colleges and Experiment Stations at its convention in 1901 favored the plan for the school and voted that, if the success of the first session seemed to justify its continuance, it be made a cooperative enterprise under the control of the association. Believing this movement to be in line with the objects for which this Department was created, I gave it my cordial approval, and on my advice the Director of the Office of Experiment Stations consented to act as dean, and other officers of the Department of Agriculture to be members of its faculty. Under these favorable auspices there was little difficulty in securing a strong faculty. As actually organized, this included 35 men, of whom 26 are professors in agricultural colleges, 7 are leading officers of the Department of Agriculture, and 2 are officers of the New York State experiment station. Courses were offered in agronomy, zootechny, dairying, and breeding of plants and animals. The school was housed in the substantial and well-equipped agricultural building of the Ohio State University, where were illustrated the most improved apparatus of instruction in soil physics, dairying, and other agricultural subjects. Besides the live stock of the university farm, leading breeders of Ohio furnished choice animals for the stock-judging exercises.

General problems of agricultural science and pedagogy were discussed at the inaugural exercises and at Saturday morning conferences. Among the topics thus treated were the history of agricultural education and research in the United States; the organization of agricultural education in colleges, secondary schools, nature-study courses, correspondence courses, farmers' institutes, and various forms of university extension; what constitutes a science of agriculture; methods and values of cooperative experiments. Through social assemblies, visits to typical Ohio farms, and much informal discussion wherever the students met each other, the educational influences of the school were greatly extended. Seventy-five students were in attendance. These were drawn from 28 States and Territories, including such widely separated regions as Maine, Oregon, California, New Mexico, and Alabama. There was one student from Canada and one from Argentina. There was also one woman, and the colored race was represented by teachers from the Tuskegee Institute and the agricultural college at Greensboro, N. C. Twenty-seven of the students are professors or assistant professors of agriculture in agricultural colleges, 31 are assistants in the agricultural colleges and experiment stations, 9 are recent college graduates, and 8 are engaged in farming.

Considering the character of the faculty and students, it goes without saying that the whole period of the session was occupied with the most earnest and profitable work. Without doubt the influence of this school will be felt throughout the country in the improvement of courses of instruction in agriculture and the strengthening of the lines and methods of investigation of agricultural subjects. In other ways the school will exert a beneficial influence. So rapid has been the accumulation of materials for a real science of agriculture during the past few years that even professional students of agriculture have not realized how large a mass of knowledge is already available for molding into a systematic body of truth which may be utilized for pedagogic purposes, as well as for inductions of scientific and practical value. The summaries given by the experts gathered at this graduate school have emphasized this fact and shown in a striking manner that agricultural education and research may now be properly and efficiently organized with reference to the science of agriculture itself, rather than be as heretofore very largely a matter of the sciences related to agriculture. This will serve to stimulate greatly the movement already begun for the reduction of the materials of agricultural science to "pedagogic form" for use in colleges and secondary schools, and for the reorganization of agricultural institutions of research on the basis of the divisions and subdivisions of agriculture instead of physics, chemistry, botany, and other primary and secondary sciences. The day will thus be hastened when the science of agriculture will rank as one of the great systems of knowledge of direct benefit to mankind.

Improvement of Rural Schools.

We are, without doubt, in this country just on the edge of a great popular movement for the improvement of the conditions of rural life through the improvement of the rural schools. As one phase of this movement there will come the broadening of the instruction in the principles of agriculture, so that in addition to college courses we shall have secondary courses in ordinary and special high schools, and even some elementary instruction in the common schools. In establishing the lines and methods of secondary and elementary instruction

in agriculture so that it may be useful and attractive to the masses of our rural youth, the leaders in agricultural science gathered in the Graduate School of Agriculture this summer will play an important part, and it is believed that they have gone out from this school with much inspiration to renewed efforts in this direction. For both the thorough establishment of the science of agriculture and the wide popularization of this science, the new school will, it is believed, be an efficient agency, and I hope the way may open for it to become a permanent institution.

The Agricultural Colleges.

A number of the agricultural colleges have made considerable progress during the past year in strengthening and broadening their courses in agriculture. Specialists in agronomy, animal husbandry, soil physics, soil bacteriology, dairying, and other branches of the general subject of agriculture have been added to their faculties. This has made it possible to materially increase the number of different courses in agricultural subjects offered to their students. This is especially true of the short or special courses in agriculture for students who for one reason or another are not able to take the entire course leading to the bachelor's degree.

Statistics of attendance at the land-grant colleges for the year 1901 show that over 42,000 students were enrolled. This was an increase of nearly 7 per cent over the attendance for the previous year. The total attendance upon four-year courses in agriculture (including dairying) increased more than 26 per cent. The number of students in special courses has fallen off relatively, indicating a growing recognition of the greater value of the full collegiate course in agriculture as compared with specialization along narrow lines in undergraduate work.

During the past two years there has been a remarkable increase in the number of buildings erected at these colleges. It is estimated that during this period at least $2,000,000 have been spent by the States for this purpose. In these buildings there are not only improved facilities for instruction in the sciences related to agriculture, but also more particularly for the teaching of the different branches of the science of agriculture itself. The changes in equipment and in the organization of faculties have put college instruction in agriculture largely on a new basis. Since the new courses deal much more largely directly with agriculture, both as an art and a science, the students are not only well trained in the theory of agriculture, but are brought much more closely into sympathy and actual contact with the practice of the art. Each year the chasm which formerly existed between science and practice is being more strongly bridged. Stronger bonds of sympathy and effort are uniting scientists and farmers through the medium of the agricultural institutions. The colleges therefore not only occupy a better position in the educational world, but they are also more strongly intrenched in the confidence and support of the great masses of practical men.

Secondary and Elementary Schools of Agriculture.

Institutions for secondary and elementary instruction in agriculture are becoming more numerous. Schools of this class already established have been continued, new schools are being established, and courses of instruction in agriculture, nature study, and gardening are being introduced into existing public and private schools. The marked success

of the agricultural high schools established in connection with the universities of Minnesota and Nebraska indicates that there is a demand for agricultural courses of parallel degree with those offered in various manual arts in our city high schools. Already there is a promising movement for the establishment of special agricultural high schools in different localities separate from the colleges, and some instruction in agriculture is now given in a number of normal and public high schools. Students taking such high-school courses would undoubtedly be able to better appreciate the work of this Department and the agricultural experiment stations and would have a better outlook regarding the movements of our times for the improvement of agriculture, which would enable them to become intelligent, progressive, and successful farmers. All over our country farmers are sending their children to public high schools and paying tuition for their instruction. They have, therefore, good reason to urge that courses on subjects related to agriculture should be introduced into these schools, especially in towns which are wholly or largely dependent on the neighboring farms for their commercial success, if not their very existence.

Since the funds expended in promoting technical education in agriculture are in the nature of investments which will be richly repaid in larger amounts of assessable farm property and the increased wealth that comes from improved farm products, both the States and the local communities can well afford to make liberal contributions to the support of courses in agriculture in the secondary schools as well as in the agricultural colleges.

Progress is also being made in the movement for the consolidation of rural schools which has already resulted in improved conditions in the schools of Ohio, Massachusetts, Iowa, and other States. Such consolidation makes it possible to introduce nature study in which matters pertaining to agriculture, horticulture, and domestic arts are easily included. Several States have already passed laws requiring teachers to prepare themselves to give instruction in nature study and agriculture, and exercises and illustrative material for such work are being more frequently published, often with the aid of the teachers in the agricultural colleges.

Another closely allied movement at present manifest principally in the city schools is the school-garden movement—the introduction of garden work with flowers and vegetables into the graded schools as a weekly or semiweekly exercise. Wherever work of this kind has been tried under proper supervision it has aroused considerable interest on the part of the students, has furnished excellent material for nature-study work, and has correlated well with the other studies in the curriculum.

Farmers' Institutes.

In my last annual report I recommended that an appropriation of $5,000 be given to enable the Office of Experiment Stations to undertake work connected with the promotion of the farmers' institute system in this country. The appropriation was to be used in employing an officer who would devote his time and energy to this work, visit institute workers and advise them regarding the ways in which the Department might help the institutes, study the problems of institute management at home and abroad, and seek to shape the Department's work for the institutes so that it might be most helpful to this enterprise. As the matter was finally fixed in the appropriation act, only about $2,000 of the income of the Office of Experiment Stations for

the current fiscal year can be used for this purpose. This is entirely inadequate for the work planned, but will be used in gathering statistics of the institute movement and in employing, during a part of the year, an officer who will be retained as farmers' institute specialist, if Congress shall provide sufficient means for continuing the work.

Farmers' institutes are now held in 44 States and Territories, including Hawaii. Nearly complete returns from 40 States and Territories show that in the areas reported about 2,300 institutes are held annually; that the funds expended by the different States and Territories in support of these institutes (not including expenses incurred by local authorities) amounted to about $196,000 per annum, and that about 709,000 people attended the institutes. The number of students taking the agricultural course at the agricultural colleges in the same States and Territories during the year ended June 30, 1901, was 9,623, including those who are recorded as attending courses in household economy, dairying, and veterinary science.

The total number of persons reached by the farmers' institutes and the agricultural colleges (about 720,000) is, however, only a small percentage (7.2 per cent) of those actually engaged in agricultural pursuits (about 10,000,000). The publications of the experiment stations are sent to about 500,000 farmers. A great need of our educational system is, therefore, wider dissemination of the results of agricultural study and research among those now actually engaged in farming.

I recommend that an appropriation of $6,000 be made by Congress to enable the Office of Experiment Stations to aid the farmers' institutes during the fiscal year 1904.

Experiment Stations in Alaska.

Agricultural experiment stations were maintained during the fiscal year 1902 at Sitka, Kenai, and Rampart. The experimental work has included the growing of cereals and vegetables, methods of reclamation, drainage, and fertilization of land, and the curing and ensiling of forage crops. In all these lines successful results were obtained, and much information which will be of use to persons attempting agriculture in Alaska was acquired. The survey of different portions of Alaska with reference to their agricultural possibilities was continued. The special agent in charge made a journey through a large portion of the Yukon River Valley. A reconnoissance of the Copper River regions and portions of the Fortymile country and the Tanana River Valley was made during September, 1901, by the assistant who had been in charge of the station work at Rampart. He estimated that in the region covered by his journey there was some 2,000,000 acres of land suitable for farming and pasture. Grass grew abundantly and luxuriantly in large regions.

The distribution of seed of hardy varieties of vegetables, cereals, and grasses has been continued and extended, seed for use the present season having been sent to some 750 addresses. Many reports of trials of seed previously sent have been received, and in this way much useful information has been secured. It is evident that the efforts made by the Department to aid the residents of Alaska in their agricultural work by distributing improved varieties of seeds have produced beneficial results. Not only has this been of advantage to the white population, but the natives also are learning to cultivate gardens, and it is reliably reported that there is a large increase in the number of natives who attempt to cultivate small patches of ground.

[illegible] Alaska has been increased by the [illegible] shop at Sitka and [illegible] at Kenai. During the [illegible] establishing a nursery of [illegible] amount of work in this line can be [illegible] to the station staff. It is also [illegible] Angora goats, with a view to ascertaining whether they can be successfully reared in the coast [illegible] Alaska. The plants naturally growing in this [illegible] forage for goats. The work at Kenai [illegible] will be carried on at Rampart [illegible] Yukon River region.

[illegible] The cost of this work will be about $2,000. As [illegible] quarters building at Sitka during [illegible] work in animal husbandry begun. This [illegible] of a farm there and the employment of [illegible] The station at Sitka should have an equipment [illegible] for simple chemical work.

As [illegible] one of the stations is on the present basis it will [illegible] more than maintain the stations at Sitka and Kenai [illegible] a very limited amount of work at one or two places in the interior.

Hawaii Experiment Station.

A large amount of work has been done at the Hawaii experiment station during the past year in clearing and preparing for cultivation portions of the tract reserved for the station and establishing plantations of fruit and other valuable trees and experimental plats. The buildings begun the previous year were completed, and the station now possesses a residence for the special agent in charge, an office and laboratory, stable, cottages for laborers, water tanks, etc.

Experiments have been begun with potatoes and taro to overcome the very destructive diseases which seem to threaten the extinction of these crops. Taro forms the principal food of the Hawaiians, and the ravages of the blight have so curtailed the supply that there has been actual suffering in some places because of the shortage. At present the experiments are being confined to the lowland taro, and an effort is being made to find some remedy for the disease that attacks the plant. Dry-land taro does not appear to be as susceptible to disease, but will be studied also. It was found in many cases that immature and diseased cuttings were used for planting. The lowland form of taro requires extensive irrigation, and in practice the land is kept flooded for a considerable time. Wherever the water was allowed to become stagnant it was found that the root rot was most prevalent. By the use of fertilizers it was found possible to actively stimulate the growth of the plant and make it less liable to disease. Wherever a liberal application of lime was made there was no disease, and with care in the arrangement of the water, selection of cuttings, rotation of crops, use of lime and fertilizers it was found possible to not only reduce the disease, but to considerably increase the production of the crop. The experiments with potatoes were conducted upon the island of Niihau in cooperation with one of the residents of that island. This island formerly produced the most of the potatoes grown in the archipelago. A disease locally known as black rot has for ten or more years

been seriously depreciating the crop. This, as has been determined by the station authorities, is due to a soil fungus, and experiments are being undertaken to combat it. In the field investigations 45 varieties of potatoes were grown under similar conditions, and marked differences were noted in the susceptibility of the varieties to disease. This work is to be followed up in the hope that some sorts may be found which are nearly or quite resistant to disease.

Investigations were begun on the diseases of poultry, and a bulletin was issued in which suggestions were given for the care of fowls and treatment of the diseases to which they are especially subject, and as a result of which poultry and eggs are excessively expensive in the Hawaiian markets.

Attention has also been given to fiber plants, mangoes, the castor bean, pineapples, peppers, and rubber and cork oak trees, and other plants believed worthy of investigation and development. A study has also been made regarding the use of pumps for irrigation purposes in the Hawaiian Islands, where the pumping of water for this purpose has in all probability reached its highest development. Members of the station staff have visited other islands of the group and an attempt has been made to get into touch with all the agricultural communities. Farmers' institutes are being organized under the auspices of the station. Bulletins on chickens and their diseases and on taro have been prepared and others are in course of preparation. It is clear that there is a wide field for agricultural investigations in this Territory. Owing to local conditions of soil, temperature, rainfall, and other natural conditions, the station will be obliged to do much work in different localities.

The presence of enormous numbers of destructive insects is one of the chief obstacles to agriculture in Hawaii. The land areas are small and the uniformity of seasonal temperatures presents no check to the development of insects which may have been introduced from continental regions. As a result the insects speedily lose their distinctive habits. Many of the introduced species no longer have a definite life period, but breed at all seasons and are practically in continuous existence throughout the year, swarm following swarm, with no intervening period when the land is free from their ravages.

There are a number of serious fungous diseases of plants which require investigation, both because of the local losses caused by them and on account of the possibility of their being carried to other parts of the islands. The work on the taro rot and the Fusarium disease of the potato will need to be continued for several years.

There are many problems of both scientific and practical interest which require the services of a chemist. Soil and water analyses, the study of the rôle of mineral nutrients in plants and soils, the composition of Hawaiian foods and feeding material all should be given attention. Investigations should be made as the occasion requires of other agricultural products which may lead to the establishment of local industries, such as fiber plants, tans, dyestuffs, rubber, vanilla, coffee, tobacco, silk, fruits, and vegetables.

Considering the numerous agricultural problems requiring investigation in the Territory of Hawaii, the experiment station there should have added to the station force a chemist; the apparatus and other equipment should also be increased, and provision made for the printing and distribution of station publications.

Porto Rico Experiment Station.

The agricultural experiment station in Porto Rico is now established on a permanent basis. This result has been secured through the cooperation of the insular government and legislature. A bill appropriating $15,000 for the purchase of a suitable tract of land for the station was passed in February, 1902. Under this law bids were called for which were closed the 12th of May. The result of these negotiations was the purchase of approximately 230 acres of land adjacent to the city of Mayaguez. The land is varied in character and well located with reference to the city. It gives promise of making a very desirable site on which to carry out the objects of the experiment station.

On this tract it is proposed to begin field tests of leguminous crops, grasses, corn, rice, beans, and vegetables. A nursery and orchard of tropical fruits, including those grown on the island, and promising varieties from other countries will be established for experimental purposes. With the temporary experiments undertaken last year much useful information has been obtained regarding soil and climatic conditions as related to the growth of crops in the island. An important study has also been made of the Changa, a mole cricket, which is the most injurious insect of the island, and a bulletin regarding this insect will soon be published in both Spanish and English for distribution in Porto Rico. Experiments looking toward the improvement of coffee, now grown so largely in the island, have already been well begun, and it is proposed to extend them materially during the coming year.

It is important that the Porto Rico station should undertake experiments with live stock, but it will not be possible to do much in this direction unless the resources of the station are increased. Additional funds will be required for the employment of a competent live-stock expert, the purchase of animals, and the general expenses of feeding experiments. In order to effectively conduct experiments with fruits a horticulturist should be added to the station staff.

Now that the Porto Rico station is permanently located, it should, in my judgment, receive the same financial support from the National Treasury as is given to the stations organized under the act of Congress of March 2, 1887. Considering the large population to be maintained by agriculture in Porto Rico, every effort should be made to develop the agricultural resources of the island. The station will be called upon to aid in the solution of a great variety of problems. The range and effectiveness of its work will necessarily be limited by the funds at its command. When the nation does as much for the Porto Rico station as for stations in the other States and Territories, there will still be need for additional financial assistance from the insular government. The cordial support which has been given the station by the Government and the substantial grant of money voted by the insular legislature for the purchase of land for the station have given evidence that the people and government of Porto Rico appreciate the importance of this enterprise and are willing to supplement the efforts of the National Government in this direction. As the work of the station develops, additional buildings and equipment will be needed, and it is confidently expected that these requirements will be met by the local legislature.

Nutrition Investigations.

The nutrition investigations have been continued along the same lines as heretofore, including dietary studies, and digestion, cooking, and

metabolism experiments. These studies have been carried on in cooperation with universities and experiment stations in Maine, Massachusetts, Connecticut, New York, Tennessee, Illinois, California, Minnesota, Vermont, and Georgia. The respiration calorimeter used in these investigations has been improved, and the studies during the past year with this apparatus have had reference especially to the relative efficiency of fats and carbohydrates as sources of energy for the performance of muscular work. To further study the relation of diet to muscular work, dietary studies with lumbermen performing severe work in the forests of Maine have been made. Among other subjects of investigation have been the digestibility and nutritive value of bread made from different kinds of flour; the effect of cooking on the nutritive value and digestibility of different kinds and cuts of meat; the relative nutritive value of different kinds and combinations of fruits and nuts, and the comparative metabolism of nitrogen, sulphur, and phosphorus. Five bulletins regarding the results of nutrition investigations were published during the past year. Special efforts have been continued to bring the results of this work to the attention of schools and colleges, physicians, scientists, superintendents of public institutions, persons engaged in philanthropic enterprises, etc.

At the summer school of nutrition and bacteriology, held at Wesleyan University, Middletown, Conn., in July, 1902, under the direction of the special agent in charge of nutrition investigations in connection with his work as professor in that institution, the methods and results of the nutrition investigations of this Department were explained to a considerable number of teachers of domestic science from different regions, and others who have engaged to a greater or less extent in the teaching of nutrition, bacteriology, and kindred subjects in the agricultural colleges and other institutions.

As stated in my previous report, it is very desirable to extend the nutrition investigations through a systematic study of dietaries in public institutions. Plans for beginning this work have already been made and considerable material, including summaries of results of early investigations, has been collected. Through an arrangement with Dr. A. B. Richardson, superintendent of the Government Hospital for the Insane in the District of Columbia, dietary studies will be made in that institution during the current year in accordance with plans furnished by this Office.

In early times the idea was prevalent that the diet of prisoners and other delinquent classes should be so poor and inadequate that it constituted a punitive measure. This is now recognized as wrong, and most civilized nations endeavor to feed such persons adequately. The food requirements obviously vary with the amount of work performed, and in most cases it is essential that the cost of the food be moderate. Food investigations are required in prisons and other institutions in order that satisfactory dietary standards may be formulated, and also to compare the rations actually fed with proposed standards. The importance of such studies has been often recognized in the past; for instance, under the authority of the institutions' commissioner in Boston, Mass., dietary investigations were carried on in a number of reformatories, etc., in that city. Studies have also been made at the reformatory at Elmira, N. Y., some of which had the special object of determining whether it was possible to favorably affect the moral welfare of inmates through their diet.

Under special government authority the diet in Scotch prisons has

been recently studied, and mention may also be made of recent work of a similar nature in Berlin. In many cases it has been found that it is possible to furnish a more satisfactory diet and at the same time diminish the cost.

Nutrition investigations have also been made in almshouses, orphan asylums, and similar charitable institutions in times past in this and other countries—Germany having taken the lead. The importance of providing a proper diet for inmates of such institutions has received government recognition in Great Britain, and investigations bearing on the subject have been undertaken there. An adequate diet should unquestionably be supplied to all who are dependent on charity of this sort. The numerous studies which have been made show that with proper care good food may be provided at a reasonable cost. While the diet in many institutions is undoubtedly satisfactory as regards kind and cost, it is not too much to say that in very many others dietary studies would show the possibility of diminishing the cost and at the same time improving the quality. The benefit to the inmates and saving of public money in this way seem worthy of all possible effort.

In previous reports I have called attention to the fact that investigations were needed to determine the food habits and requirements of residents of tropical countries. This matter is becoming of increasing importance, owing to the continuance of soldiers, sailors, and civil officers of the United States in such regions. This, and the fact that large numbers of our people are called to tropical regions by our rapidly extending commerce, would seem to justify the institution of such investigations to determine the most suitable diet under the new climatic conditions. It is well known that a suitable diet is a matter which has a great effect upon the maintenance of good health of old residents in tropical countries, and is even more important for recent arrivals. The U. S. Army has devoted considerable attention to this subject, as have also German, British, and other European investigators, generally under the auspices of the army or navy of their respective Governments. The lack of agreement regarding the diet best suited to residents of the Tropics shows that more extended investigations are required.

The economic feeding of troops and other residents in tropical regions obviously depends in some measure upon the utilization of local food products. Many of these products are comparatively unknown outside the Tropics, and their food value has never been studied.

Irrigation Investigations.

Two causes have operated during the past year to increase the interest in the Department's work for irrigated agriculture. One was the desire of the arid States for the creation of conditions which will result in the largest and best use of the water supply, and the other the drought which prevailed throughout the Middle West in 1901 and in the South during 1901 and the present year. As a result of this interest, requests for information and advice have been far more numerous than ever before, and it is only through the increased appropriation made by the last Congress and the better organization of the work that these demands have been met.

The distribution and use of Western rivers require that the irrigation industry shall be organized, and in order to provide for this it is necessary that there be a better understanding of the subject than now exists. The first need is for the facts. We need to know how much

water is being used, where it is being used, how much water is required for the maturing of crops, how it can be distributed with the least loss, and how applied to the best advantage. This information the Department is securing and disseminating through this investigation, and in doing this it has enlisted in its service many of the leading irrigation engineers and scientists of the arid States. The services of these men would have involved a prohibitory expense if it had been necessary to employ them continuously, but through cooperative arrangements with the State agricultural colleges and experiment stations and the State engineers' offices the scope of both local and national investigations has been broadened and made more effective, while the outlay to each of the parties to these arrangements has been greatly reduced.

THE DISTRIBUTION AND USE OF WATER.

The Department is now making measurements of the water used in irrigation in all of the arid States but one and in a number of humid States. The results of these studies during the past three years, while not conclusive, have already done much to educate farmers and ditch managers as to the direction from which improvements of methods and practices must come. They have made plain the need of better work in constructing and maintaining canals. They have shown that the water lost through leakage in transit is far greater than has been generally supposed, and that its loss causes a double injury. It returns in many instances to the surface of lower-lying fields and converts productive areas into unsightly swamps and marshes, rendering them for the time practically worthless. The loss of water through evaporation from these submerged areas is large. If this could be prevented and the water saved applied to crops it would largely increase the cultivated area. One of the leading lines of work of these investigations will therefore be a more careful study of losses from seepage, in order to determine measures by which this can be lessened.

In a number of instances these studies have led to careful inquiries by canal owners to determine whether or not it will be profitable to cement the main ditches and canals, and to requests for further assistance from this investigation to determine how this may be done to the best advantage. The Report of Irrigation Investigations for 1901 will give the methods pursued and the cost of cementing one of the principal canals of southern California.

DRAINAGE SURVEYS.

In response to numerously signed petitions from the agricultural and horticultural interests of the valley of Kings River, in California, the Department has carried on a comprehensive drainage survey to determine what plans can be best adopted for relief of the overwatered lands of that section. This work has been under the direction of Prof. O. V. P. Stout, of the University of Nebraska, and the report, which is now approaching completion, will give the plans and estimates for two methods of removing the surplus water and making it available for use elsewhere. The carrying out of these plans will probably require additional legislation on the part of the State, and a local committee has been formed to frame bills and promote the enactment of needed laws.

At the request of the Hon. A. J. McCune, State engineer of Colorado, the Department has assisted in the investigation of the drainage

problems of that State. This work is under the direction of C. G. Elliott, a drainage engineer of wide experience. The information already gained makes it certain that these studies are to be worth many times their cost, both to the localities where they have been carried on and in their influence on the larger and better use of the water supply. Some fears have been expressed that the water coming from these drains would be unfit for use because of the large percentage of alkali it contained, but analyses made by the State experiment stations of Colorado and California have shown that this is not the case.

STUDIES OF IRRIGATION LAWS.

The larger problems which the complete use of Western rivers is destined to create and the measure of public control which recent irrigation legislation renders inevitable gives added interest to the Department's studies of the legal and economic phases of irrigation. The division of the water of streams among farms scattered for hundreds of miles along their courses, so that each acre cultivated shall receive its just share of the common water supply, is one of the most complex administrative problems which confronts Western agriculture, and the establishment of titles to these streams by methods which shall prevent speculative appropriations of water and the creation of water monopolies is one of the imperative needs of the immediate future.

The larger opportunities which national aid affords should awaken the civic pride of the States benefited in seeing to it that not only in material development but in their institutions the irrigation systems of this country rank among the foremost of the world.

A beginning of the studies of the conditions and experiences of other lands was made during the past year. Mr. C. T. Johnston, assistant chief of these investigations, visited Egypt for this purpose. Through the courtesy of Government officials he was enabled to become fully acquainted with the administration of the laws which govern the use of the Nile, and his report will show the character of the rights to water recognized and the manner in which these rights are enforced in times of scarcity. While differences in conditions will doubtless prevent the adoption of many of the methods pursued, the lesson of one of the oldest irrigated countries in the world can not fail to be of great interest and value to one of the youngest. In addition, Mr. Johnston's report will present many matters of practical information regarding the size and construction of canals, the manner in which water is distributed and applied to crops, and the yield and value of the products.

A number of the arid States are cooperating with the Department in these studies of sociological and legal problems. Montana and Nevada appropriated money for such studies, and the irrigation officials of Wyoming, Colorado, and Idaho have given both personal and official aid. No branch of the Department's irrigation work has received more cordial recognition than its studies of legal and sociological questions, and it is believed that they are destined to exert a beneficent influence on the future industrial life of the West.

IRRIGATION IN THE HUMID STATES.

The development of the rice industry in Louisiana and Texas has had the effect of enormously increasing the value of land hitherto used only for grazing purposes or not at all. Its success has led to the investment of large sums of money and a marked increase in the pop-

ulation. In the amount of money invested in canals and pumping plants and in the increase in the acreage reclaimed, the rice districts of Louisiana and Texas have made as great progress during the past two or three years as any of the irrigated districts of the West. This rapid growth has given rise to a number of practical problems in which the aid of the Department has been invoked.

Establishing and maintaining pumping plants requires a knowledge of the amount of water required, the cost of furnishing it, and the methods by which waste in use may be reduced to the minimum. The light rainfall of the past two seasons has also made it manifest that the time is not far distant when there will be need for establishing rights to the use of streams and some division of their water supply among these irrigators. During the present season the rainfall from June to September was little more than that of many of the arid States, and this, combined with the large increase in the irrigated acreage, has made the drain on some streams cause their current to be reversed and salt water to flow in from the Gulf.

The growth of irrigation in the Southern States is not, however, confined to the rice districts. During the past year the experts of this investigation have furnished information and advice to farmers in Georgia, Alabama, and the Carolinas under which a number of irrigation systems have been installed. The drought of the present season has made the first year's trial a marked success, but it will require a number of years to determine to what extent irrigation can be profitably employed in this section. The fact that the Department was able to answer these inquiries has saved large sums of money to individual farmers. In nearly every instance they had planned to put in pumps of too small capacity to have been of any real service, and the attempts would have resulted in disappointment and loss and probably have delayed adoption of what promises to be an important aid to both agriculture and horticulture.

The cooperative irrigation studies undertaken in connection with the State experiment stations of Wisconsin, Missouri, and New Jersey have been continued, the object being to determine how far and by what method irrigation can be profitably employed in the humid States.

In view of the increased interest in the questions with which the irrigation investigations of this Department deal, growing out of the rapid development of our irrigation system under private as well as public auspices, there is constantly enlarging demand for the services of our irrigation experts and for the published results of their investigations.

Agricultural Engineering.

In order to answer the inquiries received by the Department and to make the irrigation investigations of the greatest practical benefit, it has been necessary to include studies of the applications of power whose relation to irrigation is made apparent only by a thorough understanding of existing conditions. Farmers under irrigation apply to the Department for information regarding the use of streams and canals for power purposes. Many who desire to irrigate small tracts apply to the Department for information as to whether or not pumping will pay, the kind of pumps to be used, and the amount of water required. Inquiries are received as to the relative economy of different forms of power, and whether coal, oil, gas, electricity, or wind power will best serve the irrigator's purposes. These questions should

be answered because nothing is more wasteful than to have each man learn experimentally for himself what has been found out elsewhere, but the attempt to do this has made agricultural engineering an important feature of these investigations, and raises the question whether the usefulness of the work of this Department can not be materially augmented by entering upon a systematic study of agricultural engineering as related to the interests of all our farmers.

The possibilities of this subject can be illustrated by the one item of farm machinery. In the past twenty years the capital invested in the manufacture of agricultural implements has increased from sixty to one hundred and fifty-seven millions, and the value of the product has more than doubled, but more significant than this increase in its importance have been the changes in its character. Leaving out of consideration the larger and more important classes of farm machinery, such as reapers, mowers, and thrashers, which are usually thought of as supporting the claim that American inventive genius and mechanical skill have surpassed the world in constructing farm machinery, and taking up machines and implements but little thought of in this connection, it will be seen that the changes wrought in the past twenty years have been little less than revolutionary, and have been an important factor in maintaining our commercial supremacy. The invention of the disk harrow to supplement the types formerly used, the invention of the disk plow to compete with the types in use for centuries, the still more recent invention of corn-harvesting machinery, all serve to show the rapidity and radical character of the evolution which is now going on.

These facts, in connection with the increasing demand for efficient labor-saving devices resulting from the growing scarcity of farm labor and the organization and development in foreign countries of institutions for the systematic study and improvement of farm machinery, renders it important that we should not longer neglect this field of inquiry. There is an excellent opportunity for the Department to do an important service in promoting the continuance of our agricultural supremacy through the use of farm machinery by investigations regarding the fundamental principles on which the further improvement of such machinery must depend.

At present the Department is not in a position to answer the numerous requests for information on these subjects, and these demands will undoubtedly increase with the growing application of new forms of power to farm work and the development of new kinds of labor-saving machinery. The agricultural colleges and experiment stations throughout the country are beginning to realize the need of such studies, but they find great difficulty in establishing the work on an efficient basis owing to the lack of definite information in available form. It is believed that this Department should undertake to collate and publish such information, as well as to institute investigations which will keep the farmers and manufacturers of the country informed of the progress being made and show them the lines in which it may be extended.

Investigations in agricultural engineering should also include problems relating to the laying out of farms, such as the arrangement of buildings, drains, water supply, and disposal of sewage. The character of the agriculture of the twentieth century has made farm buildings as complex in design and varied in use as factories, and there is a wide field of study for improvement in design and for determination of the best material to be used in their construction.

The breeders of high-bred and valuable live stock need to give almost as much attention to stable sanitation as is given to house sanitation, but the data on which to plan efficient systems of ventilation are of the most limited character. It is believed that careful studies of the designing of farm buildings will be a benefit to agriculture, not only in saving large sums of money in the selection and combination of material used, but in the adoption of more convenient and effective plans.

Need of Adequate Funds.

This review of the work of the Office of Experiment Stations in all its phases shows very conclusively the necessity for more liberal appropriations, as submitted in my estimates for the ensuing year, for carrying on the several lines of work assigned to the Office of Experiment Stations. It is particularly desirable that the stations in Alaska, in Hawaii, and in Porto Rico, which are under the direct supervision of the Secretary of Agriculture, should be as liberally dealt with in this respect as are the stations in the several States and Territories of the Union.

DIVISION OF FOREIGN MARKETS.

Investigations made by the Division of Foreign Markets regarding the status of our agricultural export trade in the principal markets of the world disclose an exceptional activity on the part of some of our most formidable competitors for that trade, and particularly such countries as Australia, Canada, and Argentina. These progressive exporting countries have within the last few years been taking exceedingly active measures for the extension of their foreign business. As was pointed out in a publication recently issued by the Division on the subject of the British agricultural import trade, about two-thirds of the farm produce required by the British people to supplement their domestic supply is now being purchased from the various competitors of the United States. The success of these competing countries suggests the importance of constant watchfulness in the interests of our own export business.

Agricultural Exports in 1902.

Statistics recently prepared by this Division show that the agricultural exports of the United States for the fiscal year 1902 had a value of about $860,000,000. In comparison with the record-breaking figures of the preceding year, the value for 1902 exhibits a rather marked decline. Next to the exceptional record for 1901, however, it is the largest ever reported, being decidedly above the average of the decade.

The decline from the high mark reached by our agricultural exports in 1901 was principally due to the fact that a serious shortage in the corn crop left a comparatively small supply of this important export grain available for shipment to foreign markets. Our exports of corn during 1902 amounted in value to only $16,000,000, while in 1901 we sent abroad consignments worth nearly $83,000,000. The loss to our trade through the diminished shipments of this product alone exceeded $66,000,000.

Aside from the extraordinary falling off in corn exportation, the most noticeable instance of decline occurred in the shipment of cotton. Our cotton exports for 1902 had a value of $292,000,000, or about $23,000,000 less than the figures recorded in 1901, when there were shipments worth $315,000,000.

Trade in Forestry Products.

The more active interest recently aroused in the question of forestry in the United States has created a larger demand for statistical information regarding our commerce in forestry products. To meet this demand the office devoted considerable time during the year to the preparation of statistics on the subject.

Last year the United States exported nearly $50,000,000 worth of forest products. Lumber in its various forms, not including heavy timber, comprised the principal item, the shipments under this head having a value of about $26,000,000. The exports of heavy timber, sawed, hewn, or in logs, were valued at about $10,000,000. Wood pulp and the minor products of the forest together formed an item of about $13,000,000.

Europe furnishes the principal foreign markets for American lumber. The United Kingdom is decidedly the largest purchaser, but extensive sales are also made each year to France and to Germany. Markets for our lumber, however, are found in nearly every quarter of the world. The neighboring countries of Canada and Mexico make considerable purchases. A promising market is now being developed on the island of Cuba, where in 1902 consignments worth over $1,000,000 were received. During the last few years a considerable export business in lumber has been established with the Philippine Islands. In 1902 shipments valued at $246,000 found a sale there. These islands, although rich in tropical hard woods, promise to afford an extensive market for the building lumber supplied so abundantly by the great timber districts of our Pacific slope region. Additional markets for that region will undoubtedly also be developed in other parts of the Orient.

Notwithstanding the immense timber areas of the United States, a larger sum is annually expended in the importation of forest products than is received in payment for such products exported. This is because of our extensive requirements as regards certain articles yielded only by the forests of the Tropics. It is quite probable that before many years the island possessions of the United States, and particularly the Philippine Islands, will supply a large part of the tropical forest products we are now obliged to import from foreign sources.

Trade with Island Possessions.

In view of the lively interest that is taken in the course of trade between the United States and the several island possessions, the office recently prepared some statistics to show the status, so far as products of agriculture are concerned, of our commerce during the past fiscal year with Hawaii, Porto Rico, and the Philippines. From the statistics in question it appeared that, while our agricultural trade with Hawaii suffered a rather marked decline in 1902, there was a considerable increase in the amount of such business carried on with Porto Rico and with the Philippine Islands.

OFFICE OF PUBLIC ROAD INQUIRIES.

The work of this office has been prosecuted along the same general lines as heretofore, but its practical features have been enlarged. Object lesson and experimental road work have received more attention than ever before, and efforts along this line appear to be doing much to stimulate the building of better highways in many sections. Practical work in the testing of road materials has also been continued and enlarged. The field work of the Director, his assistant, and several road experts and special agents who attend and address conven-

tions, consult with and advise road officials, and come in personal contact with the people of many communities, is another important feature of the practical work of the office which is producing excellent results.

Cooperation in Object-Lesson Road Work.

The building of object-lesson and experimental roads has during the past year assumed a position of higher importance than ever before in the work of the office. Most of this work during the past year has been done in cooperation with several forces, each having a special interest in the improvement of the public highways. The first of these cooperating forces, the National Good Roads Association, was organized by public-spirited citizens to promote, by agitation and organization, the improvement of the public roads. Its work is educational in character, and one of its aims is to organize State and district associations. The second of these forces, the manufacturers of road-building machinery, contributes to the cooperative work the use of machines for building sample roads as well as experts to operate and explain this machinery. The third, one or another of the great railroad corporations, contributes the use of a train, popularly known as a "good-roads train," to carry from place to place along its lines the machinery and the representatives of all the cooperating forces. In this work the railroad corporations are actuated by a desire to develop the country tributary to their lines, particularly to secure the improvement of the roads over which commodities must be hauled to and from their stations. The Office of Public Road Inquiries of the Department constitutes the fourth cooperator. Its work is advisory, supervisory, and educational. The people of the various communities in which conventions are held and sample roads built may be mentioned as a fifth cooperating force, and a very important one, since it is not only the principal recipient of the benefits, but must furnish the money, the materials, the common labor, and the horsepower needed in building the object-lesson roads.

The character of this cooperative work can best be indicated by briefly describing the work done in the South during the past autumn, winter, and spring. In October, 1901, the Southern Railway Company fitted up a good-roads train, consisting of a locomotive and 12 cars, which carried the representatives of all the cooperating forces and the road-building machinery furnished by five of the principal concerns that manufacture such machinery in the United States. The itinerary of this train extended through six States—Virginia, North and South Carolina, Tennessee, Alabama, and Georgia—and covered a distance of 4,037 miles, the whole campaign occupying over five months. Stops of a week or more were made at eighteen different places, at each of which a road convention was held and object-lesson and experimental road work was done.

This practical work included the improvement of earth roads, the building of gravel, chert, shell, sand-and-clay, and macadam roads, the object being to utilize local materials wherever possible and to illustrate the best methods of using them. Many thousands of people attended the sessions of these conventions and took lessons in practical road work. Addresses were delivered by many men of prominence in political, educational, and religious fields, as well as by scientific and practical road builders and representative farmers. Permanent good roads associations were organized in every State visited. It is believed that the work done has aroused a deep and permanent interest in road

improvement in the States visited, and has started a movement for better roads that will ultimately yield results of inestimable value to the South. Plans for work of similar character in several Northwestern States have been matured and will be carried out during the current year.

Aside from the cooperative work just described, the Office has done much sample-road work in cooperation with State and county officials, educational institutions, and experiment stations. In this way sample roads have been built in four States: Maryland, West Virginia, Ohio, and North Carolina.

The demand for object-lesson road work of the character indicated is very great and comes from all sections. The Office has been able to comply with only a small part of the numerous requests for its active participation in the building of sample roads. During the coming year work of this kind will be extended as greatly as the force and means of the Office will justify. It should be remembered that this object-lesson work costs the Department nothing except the salaries and expenses of its employees. In view of this fact and of its great practical value, the propriety of extending work of this kind seems apparent.

The road material laboratory is operated in collaboration with the Bureau of Chemistry, and its operations have already been discussed in connection with the work of that Bureau. The increasing demand for the services of this laboratory shows that its work is appreciated by practical road builders.

Special Agents.

The plan of dividing the whole country into four areas, known as the Eastern, Middle, Western, and Southern divisions, has been retained, but, owing to lack of funds, no special agents were appointed for the Eastern and Middle divisions. The special agents in the Western and Southern divisions have done a great deal of active field work, visiting different sections, attending and addressing conventions, collecting and disseminating information, and preparing and publishing matter on road subjects. It is expected that during the current year a special agent will be at work in each of the four divisions except the Eastern.

PUBLICATIONS.

Extent of Publication Work.

All the information acquired by this Department through its several bureaus and divisions by the means at its command finds its expression necessarily in the form of publications. The duty of issuing and distributing these publications is assigned to the Editor of the Department, under whose direction they are edited and prepared for the printer. The record of his work therefore accurately reflects the activity of the other Bureaus and Divisions of the Department. The statistics of publication work for the year, as reported by the editor, show that in no previous year since the organization of the Department has this manifestation of activity in all the branches of the Department work been so apparent.

The total number of documents issued during the fiscal year was 757, of which 85 were publications of the Weather Bureau, and the total number of printed pages of new matter edited and prepared for the printer by the Division of Publications was 18,184. Counting pages of new matter, the increase in the matter edited during the year was 25 per cent over 1901 and 75 per cent over 1900. In spite of this unprecedented increase, there were in the hands of the Public Printer

on June 30, 1902—the closing day of the fiscal year—112 miscellaneous publications, not including 47 Farmers' Bulletins.

Farmers' Bulletins.

Of Farmers' Bulletins, four-fifths of which are by law set aside for the use of Senators, Representatives, and Delegates, there were printed 6,150,000 copies, of which the Congressional distribution absorbed 4,289,126. While Senators, Representatives, and Delegates have failed to avail themselves of the full number of Farmers' Bulletins allotted to them, on the other hand, the number at the disposal of the Department has been inadequate.

Growth in the Publication Work.

The growth in the publication work of the Department during the past decade has been phenomenal. Every enlargement of the scope of the work of any one bureau or division, or the adoption by the Department of any new line of investigation or inquiry, inevitably brings about an increase in the work of publication. The development of the Department itself can therefore be accurately traced in the records of the Division of Publications.

Ten years ago the total appropriations for printing for this Department, including the salary roll of the Editor and his assistants, were less than $100,000. The total number of publications was 210, and the aggregate number of copies issued was 2,689,084. Last year the total appropriations for the same purposes exceeded $380,000; the number of publications issued was 757, and the aggregate number of copies 10,586,580. This increase, amounting to nearly 300 per cent in appropriations and number of copies issued and to over 250 per cent in the number of publications, obviously supplies an accurate measure of the growth and development of the Department itself.

Cost of the Department Printing.

The amount appropriated for printing for the use of this Department is, however, far from being the total amount expended for the publication work of the Department. The Yearbook and several other reports issued annually are paid for by special appropriations, and no session of Congress passes without special provision being made for the publication of several important reports for which the regular printing appropriation is inadequate. The cost of the publication work of the Department thus does not fall short of $800,000 a year, to say nothing of the fact that this enormous mass of published matter is carried free through the mails to all parts of this country, to Canada, and to Mexico, at an expense to the Government which can not be less than $200,000 yearly at the least.

The diffusion of the information acquired by the Department, therefore, represents an annual expenditure of about $1,000,000, a comparatively small per cent of the amount required to defray the total expenses of the Department, but one, nevertheless, without which all the other expenses would be useless. A serious problem is presented by the fact that as the Department grows and becomes better known and its work more valuable and more highly appreciated, the demand for its publications increases even more rapidly than the supply, and with a constituency of over 10,000,000 workers on the 5,750,000 farms of the United States, of which probably not more than one-tenth are reached at present in anything like adequate measure by the publications of the Department, it is obvious that the demand upon us for

published matter is bound to assume larger proportions, and, under the present system, to involve greater expense.

THE LIBRARY.

The work of the Department depends in a large measure upon an available collection of books relative to practical agriculture and to scientific experimentation at home and abroad. With this end in view the library has been increased from year to year until it now contains 75,000 volumes and pamphlets pertaining to the special lines of work carried on in the Department. As a working scientific library it is among the first, and as such is frequently made use of by scientists in distant parts of the country.

Accessions.

Each year some especially rare scientific works and many valuable sets of periodicals are added to the library, which are not available elsewhere in the country. With a larger appropriation more such works, in addition to current publications, could be procured to the great advantage of the public service.

The files of agricultural papers are particularly noteworthy, including representative publications from all parts of the world. This is one of the special collections most frequently consulted, and, in addition to its current value, it is a most important one as a source from which the progress of agriculture may be traced in future years. With few exceptions these publications are gifts from the publishers. Many gifts from scientific writers in the form of monographs and of reprints are also received, adding largely to the number and to the value of the annual accessions.

The most important source of accessions next to that by purchase is by exchange. The numerous publications of the Department are widely distributed to societies, universities, and other institutions of learning. In return for these, thousands of separate numbers of serial publications are received. The Library is the depository for all exchanges, that they may be systematically arranged and carefully preserved for the present and future benefit of the Department.

Technical Work.

The card catalogue is kept up to date. The last appropriation provided for an additional cataloguer to further this branch of the work. In addition to the card catalogue, a volume entitled "Catalogue of the Works relating to Botany in the Department Library" has been published. It is expected that two such catalogues of books on special subjects in the Library will be issued each year until a complete subject catalogue is thus printed.

The accessions bulletins have been published quarterly, as heretofore. Two additional bulletins, containing works relating to botany and to irrigation, respectively, have also been printed. The card index to the publications of the Department has been continued. The number of sets of the cards has been increased to meet the demands for the index from depository libraries.

Serial publications constitute so large a part of the accessions to the Library that it is necessary to devote much time and money to binding, both for the preservation of the volumes and for convenience in their use. The past year 1,300 volumes have been bound, and although this is the largest number recorded for any one year, it could well be doubled with advantage to the Library if funds permitted.

ESTIMATES AND APPROPRIATIONS.

The estimates for the fiscal year ending June 30, 1903, which were prepared in the Division of Accounts and Disbursements, were submitted to Congress through the Secretary of the Treasury with an explanation of all changes from the appropriation of the preceding year. These estimates amounted to $4,789,540, or $872,120 more than the appropriation for 1902. The amount finally appropriated for 1903 was $4,503,960. These amounts are exclusive of the $720,000 appropriated for the agricultural experiment stations, and the general printing expenses.

The statutory rolls of the Department increased from $533,640 in 1902 to $630,760 in 1903. This does not represent an actual increase either of salaries or clerical force, but was the result of the transfer to the statutory rolls, on the recommendation of the Agricultural Committees of both the Senate and House of Representatives, of clerks who have heretofore been paid from the lump-sum rolls of the Department.

During 1902 $12,600 was paid for the rent of buildings in the District of Columbia, and the appropriation for the same purpose for 1903 is $21,700.

OFFICE OF THE APPOINTMENT CLERK.

The records of this office show that on July 1, 1902, the total number of employees in the United States Department of Agriculture was 3,789, of which 1,209 were executive officers and administrative assistants, clerks, messengers, and watchmen; 2,081 scientists and scientific assistants, and 499 laborers and charwomen.

During the fiscal year ended June 30, 1902, the appointments made on certificates of the United States Civil Service Commission numbered 305, including 10 reinstatements and 19 transfers from other Departments. Thirty-five persons declined appointment on civil-service certificates. There were 108 resignations, 22 removals, and 14 deaths.

EXPOSITION WORK.

The Department of Agriculture, in connection with other Departments of the Government, has, in compliance with the law, participated in various expositions in this and foreign countries; and it is now preparing an exhibit for the Louisiana Purchase Exposition which is expected to be the best ever made by the Department.

It is not intended to make this an exhibit of agricultural products and resources, differing in that respect from exhibits prepared for expositions in foreign countries, where an effort has always been made to exhibit the products and resources of the country in the hope of increasing our trade abroad. It is expected that the articles and material exhibited at St. Louis will illustrate as nearly as possible the workings of the various Bureaus and Divisions of the Department, giving to the people who may not have an opportunity to visit the Department a chance to see what it is doing to promote the agricultural interests of the country.

The preparation of the Department exhibit devolves upon the heads of the several bureaus and divisions, under the general direction of the Assistant Secretary, Hon. J. H. Brigham, the representative of the Department on the Government board, and who has served on several previous occasions in the like capacity.

Since the elevation of the Department of Agriculture to executive rank, the President has honored it by naming its representative as the chairman of the Government board at the various expositions.

MAGNITUDE OF AGRICULTURAL INDUSTRY.

In the industrial progress made by the United States during recent years there has been no more conspicuous feature than the growth of agriculture. It is doubtful if the magnitude attained by our farming interests is generally known. According to the reports of the Twelfth Census, the fixed capital of agriculture, comprising the value of the land, buildings, and improvements, of implements and machinery, and of live stock, amounted in 1900 to about 20 billions of dollars, or four times the fixed capital invested in manufactures. During that year there were nearly 5,740,000 farms in the United States, covering an area of 841 million acres, of which 415 million acres consisted of improved land. These farms had a total value of $16,675,000,000, exclusive of farming implements and live stock. Farm implements and machinery formed an item of 761 million dollars, while the value of the live stock on farms exceeded 3 billions of dollars.

As further indicating the importance of agriculture in the United States, it is a striking fact that, according to the returns of the last census, about 40 million people, or more than half of our total population in 1900, resided on farms. Of the 29 million persons comprising the portion of our population engaged in gainful occupations, about 10 million, or more than a third, were returned as employed in agricultural pursuits. The people that work upon the farm outnumber by more than 3 million persons those who are occupied in the manufacturing and mechanical pursuits.

In 1899, according to the census returns, the produce of American agriculture, including farm animals and their products, had an aggregate value of nearly 5 billion dollars. Some of the crop values that make up this total were almost startling in their size. The crop of indian corn, which formed the leading item, had a value of 828 million dollars. The hay and forage of the census year were worth 484 millions. Wheat, which ranks next to corn among our cereal crops, gave a return of 370 millions, while oats were produced to the value of 217 millions. Cotton, the great crop of the Southern States, was valued at 324 millions.

In addition to these foremost crops, there were numerous others yielding returns in value that ran into the millions. Live stock and their products formed an exceedingly important factor in the grand total. The animals sold and slaughtered during the year were valued at above 900 millions. The several products of the dairy—milk, butter, and cheese—comprised an item of 472 millions, while poultry and eggs together brought a return of over 281 millions.

As a result of the intelligent application of improved methods to American agriculture, the produce of our farms has enabled us to increase the volume of our exports every year. Products of agriculture form about two-thirds of our entire export trade. Last year the exports from the farm amounted to 860 millions of dollars. The science of agriculture is in rudimentary stages in all lands. The education of producers from the field, so long neglected, has recently been undertaken in earnest in the United States. Our Government is doing more for the farmer than all other nations combined. Results are justifying expenditures, and the future will still further show the value of science applied to the farm.

Respectfully submitted. JAMES WILSON, *Secretary.*

WASHINGTON, D. C., *November 29, 1902.*

O

U. S. DEPARTMENT OF AGRICULTURE.

Report No. 74.

PROGRESS

OF THE

BEET-SUGAR INDUSTRY

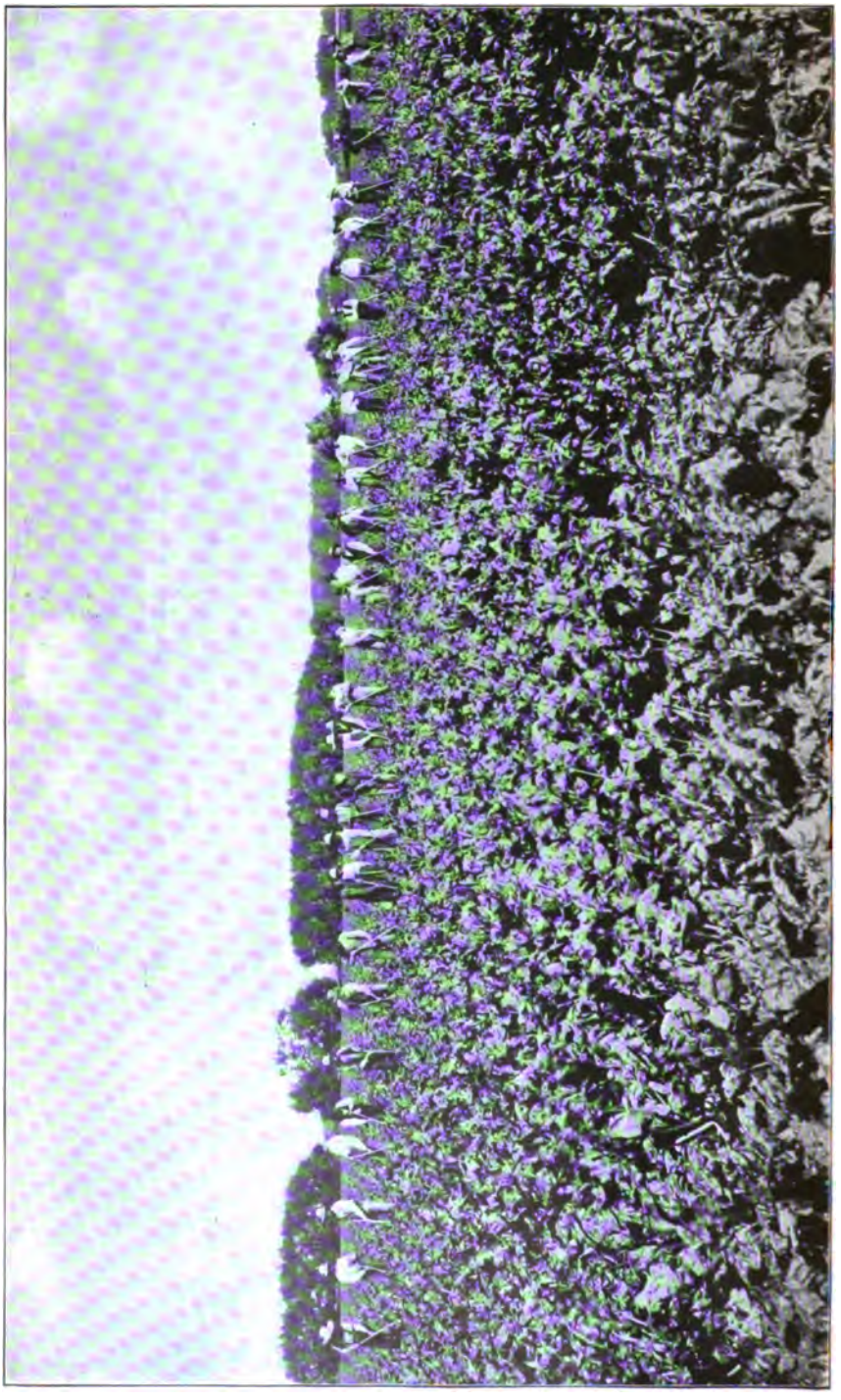
IN THE

UNITED STATES

IN

1902.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.



HOEING BEETS, NEAR AMES, NEBR.

U. S. DEPARTMENT OF AGRICULTURE.

Report No. 74.

LIBRARY OF THE COLLEGE OF AGRICULTURE

PROGRESS

OF THE

BEET-SUGAR INDUSTRY

IN THE

UNITED STATES

IN

1902.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

PREFACE.

The report on the Progress of the Beet-Sugar Industry for the year 1902 comprises the following papers:

(1) The annual report of Charles F. Saylor, special agent for the investigation of the sugar industry, showing the present status of the beet-sugar industry in the United States and the progress made during 1902, and including also a somewhat exhaustive discussion of "Sugar-beet pulp as animal food."

(2) Two papers submitted by B. T. Galloway, Chief of the Bureau of Plant Industry, the first by J. E. W. Tracy, of that Bureau, on "Sugar-beet seed: Its importance and production," and the second by Truman G. Palmer on "Single-germ beet balls and other suggestions for improving sugar-beet culture."

(3) A discussion of "The principal insect enemies of the sugar beet," with numerous illustrations, by F. H. Chittenden, of the Division of Entomology.

Previous reports on this subject have in nearly all cases been sent to the President, transmitted by him to Congress, and issued as Congressional documents; but as the last Congress had adjourned before it was practicable to complete the preparation of this matter, it seems advisable that this report be issued as a Department publication without awaiting the next meeting of Congress.

GEO. WM. HILL,
Editor and Chief, Division of Publications.

WASHINGTON, D. C., *June 6, 1903.*

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PROGRESS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES IN 1902.

REPORT OF SPECIAL AGENT,

CHARLES F. SAYLOR.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SPECIAL AGENT,
Washington, D. C., May 2, 1903.

SIR: I submit herewith for your inspection and approval the manuscript of my report for 1902 as special agent for the investigation of the beet-sugar industry. It includes a general discussion of the status and needs of the beet-sugar industry in the United States, a showing of the progress made during the past year, a forecast of developments in factory building during 1903, statistics of the industry, a discussion of sugar-beet pulp as animal food, and other matters relating to the industry.

Respectfully,

CHAS. F. SAYLOR, *Special Agent.*

Hon. JAMES WILSON,
Secretary of Agriculture.

INTRODUCTION.

In reporting on the progress of beet-sugar industry in the United States for 1902, I do so with a feeling of satisfaction inspired by a more nearly complete realization of hopes than was the case when I made my last report. Not only have more and larger factories been installed, but many of those in operation have largely increased their working capacity. Even in the face of some unfavorable aspects, which many feared would be harmful, the industry has steadily progressed to a firm footing with bright prospects for the future. A few years ago the beet-sugar industry seemed destined to make at best very slow progress in public favor. Very little was said about it in the public press, and this was confined to the special agricultural journals. Capitalists had but a vague notion of its resources and requirements. farmers and business men looked upon it as a fad, and it looked

as if, like other enterprises of the kind, this industry must necessarily go through a long and tedious period of agitation, education, and experiment. But presently it became a subject of Congressional action, and then came prominently before the country and received thorough discussion not only in both Houses of Congress, but in all the journals of the country, in clubs and associations, and in the homes of the people. Every phase of the beet-sugar industry has been canvassed in the newspapers, even papers of local circulation having contained many columns of discussion regarding the industry. Out of this has evolved a wider, more definite, and complete public information on the subject. It would be difficult to find a person of average intelligence and education in the United States who could not give some sort of general information on beet sugar and sugar beets. The people of the United States now fully understand that sugar is usually the largest item in the list of imports into the United States, aggregating in 1902 $84,871,299 in value. By producing our own sugar every dollar of this could have been kept at home, giving employment to our own laborers, farmers, and business men, and a good investment for $750,000,000 of capital.

The industry to-day has a bright future. With the signing of the protocols of the European sugar-producing countries and Great Britain, at the Brussels Conference, the artificial stimulus to overproduction of the world's sugar ended, placing the sugar industry of this country on a basis subject to no laws but those of its own enactment and those naturally evolved from healthful trade relations. The cartell of Germany will no longer place sugar on our markets at less than the cost of manufacturing it. There is an end to the unnatural arrangement which compelled the people of several European countries to pay a heavy tax on the sugar they consumed in order to subsidize the sugar exported, and thus enable the manufacturers to sell in other countries at less than the cost of production.

The country is to be congratulated on the building up of an industry that brings so many benefits to all other branches of agricultural industry, and at the same time opens up such a large field for the investment of capital and the employment of labor.

The fortunate fact that such a large area in our country having such different climatic conditions is available for growing sugar beets is one of the reasons why the industry has developed so rapidly. A few years ago the only information that could be secured regarding the growing of sugar beets in this country and the character of the beets that could be grown was that supplied by the State experiment stations and the Division of Chemistry of the Department of Agriculture. At present a factory in actual operation and the practical production of sugar beets by experienced farmers can be seen and studied by those interested without traveling a great distance. To-day the sugar

factories and beet fields all over the country are public school grounds and laboratories for actual information and illustration to capitalists, farmers, and business men. One can learn more in a day's observation in the beet field and the sugar factory than he could possibly learn with a diligent study of all the matter that was published during the experimental period of the industry. We have practically settled the main questions as to the possibility and probability of growing sugar beets, and as to their profitableness when compared with other field crops. The beet-sugar industry has come to stay and shows every indication of a profitable career. It is accomplishing results in a great many directions not anticipated in its inception. Ten years ago we had millions of acres of land throughout the arid West that seemed unfit for any purpose other than a sparse growth of grass and browse for horses, sheep, and cattle, 10 to 20 acres being required to support a single steer. This land was worth on the market from a dollar an acre down, rarely more, unless it contained mineral deposits. Most of this lnad was capable of growing grains, potatoes, alfalfa, etc., if water could be secured for irrigation. The people of the West have been working for laws for the development of their irrigation resources. The results of sugar beets under irrigation were so favorable that factories were built; the results of these factories again were so favorable that this arid country became active in the establishment of sugar factories until it appears destined to be the center of the beet-sugar industry. It seems destined also to reach the highest point of sugar-beet production, as regards purity and quality. Much of this arid cheap land belongs to the Government of the United States. I believe that in the future, through the influence of beet-sugar production in enhancing the value of the lands, the Government itself will be largely the beneficiary of this great industry it has so wisely fostered. In the language of another, it has "builded better than it knew." While the arid portions depend on irrigation for producing all field crops, yet the sugar industry appeals most strongly for active Government aid in developing the irrigation resources of the West.

The best and most conclusive evidence of the success of beet-sugar production in the United States is to be found in the disposition of those having the most extended experience to rapidly increase their interests, either through increasing the capacity of their factories or becoming interested in new enterprises. Most of the factories which have had at least two years' experience with a daily capacity of 600 tons of beets are increasing their capacities from 100 to 500 additional tons, or are seriously considering such action. Those interested in beet-sugar production when I began investigating this industry six years ago have become the foremost promoters of other enterprises. At that time there were eight factories in the United States. Let us

see, now, what developments have occurred in these factories. The owners of the factory at Alvarado, Cal., had just increased its capacity from 300 tons to 800 tons of beets daily, and have since increased it to 1,000 tons daily. The capacity of a factory at Watsonville, Cal., had recently been increased up to 1,100 tons, and through the operations of this factory its promoters were encouraged to build another at Salinas, Cal., having a capacity of 3,000 tons, probably the largest beet-sugar-producing concern in the world. While this factory has not yet succeeded in securing enough beets to supply this enormous capacity for a full campaign, every year the product of beets increases, and its owners look for the complete realization of its original plan in the immediate future. At Los Alamitos, Cal., there was a small factory of 350 tons that doubled its capacity the second year. Chino, Cal., had a small factory having a daily capacity of 350 tons, and this has been increased to 1,100 tons, the same company operating factories at Grand Island and Norfolk, Nebr., of 350 tons each, the operation of which probably inspired the one at Chino. After operating factories at these three places this company installed a factory at Oxnard, Cal., having a daily capacity of 2,000 tons, and the next year another at Rockyford, Colo., having a daily capacity of 1,000 tons, and has several other projects in contemplation for the near future. The Lehi (Utah) factory had a capacity of 350 tons, and during the last four years at different times it has constructed three auxiliary stations, each having a daily capacity for slicing 350 tons of beets. At these stations the process is simply carried far enough to extract the juice, which is piped to the main factory from distances ranging from 10 to 20 miles, where the sugar is manufactured. This gives this factory a combined capacity of about 1,400 tons of beets per day. It is understood that some of the projectors of this enterprise have been interested in the factories erected at Ogden, Utah, La Grande, Oreg., and Greeley, Colo., and the new large concern recently organized in Idaho. This company is now building a new factory in the Bear River Valley, Utah. This shows that the parties interested in the original eight factories have, in the aggregate, more than quadrupled their interests in beet-sugar production. Those operating the factory at Ogden, Utah, after two years' experience, instituted another at Logan, Utah, having a capacity of 400 tons. Many of the parties in Michigan interested in factories have become identified with later enterprises in the State or in Canada and Wisconsin. Most of the factories in Michigan which started with small capacities are doubling or materially increasing their capacities after operating one year. It may be assumed that the people possessing the best evidence are the best judges of the success of the sugar industry, and that largely increased and additional investments are strong proofs of the success of the industry.

At present the most important thing for consideration in the beet-sugar industry is the production of beets. Looking over the various important influences contributing to the future development and comparing with results in the older beet-sugar countries, I should say what we need is more beets for the factories and a higher tonnage per acre for the farmer. The average length of the working campaign in 1901 was 88.2 days. The average length of the working campaign in 1902 was 94[a] days. In order to accomplish the best results and secure all the economies of sugar production, the average length of the campaign in this country should not be less than 100 days. It should be our endeavor to make it more than that, and I confidently believe that it will be more than that.

The responsibility for the future progress of the sugar industry is largely thrown upon the farmers. It costs a large sum of money to build a beet-sugar factory. The money representing the investment in the factory must remain idle a large part of each year. It is clear that the factory can reach the best results when it secures enough beets to give it a maximum period of employment. This makes it desirable that more farmers in the vicinity of a factory shall grow beets, and that those who do grow beets shall grow larger tonnage per acre, in order that the crop shall be more profitable. Larger acreage benefits the factory; higher tonnage benefits both the factory and the farmer. It takes about 6 tons at $5 per ton, when beets are grown under rain conditions, and about 8 tons when they are grown by irrigation, to pay the cost of production. It is plain that every ton produced over these amounts contributes mainly to the farmer's profits.

In Germany and France it costs as high as $25 per acre to fertilize land growing sugar beets. In the Hawaiian Islands fertilizers for growing cane cost $45 per acre. Our farmers can afford to do more fertilizing. They can afford to give more attention to cultivation. In this way they can easily double the present average tonnage per acre.

COLLATERAL BENEFITS.

The generalizer, in the examination of a piece of cloth, would dwell upon its quality, beauty, and texture as a whole. The specialist would unravel and examine the strength and perfection of each particular thread to determine its contribution of strength in mutual relation to the other threads, deriving an estimate of the whole texture. Throughout my reports during the last six years I have endeavored to give both general and analytical views of the development of the beet-sugar industry in this country, and I shall follow the same plan in this report. I will now point out some of the collateral and indirect benefits of the industry.

[a] At a number of factories there were unusual delays on account of scarcity of coal. Eliminating these delays would reduce the length of campaign considerably.

PROMOTION OF EDUCATION.

I find that wherever any considerable interest in beet-sugar manufacturing has developed, the experiment stations and the agricultural colleges—those active agents in higher scientific culture and in the practical solution of agricultural problems—are organizing their teaching and experimental forces to meet the new duties imposed by the presence of the sugar industry. Michigan has already arranged a course for teaching young men the sciences underlying this industry, and the State experiment station is training men especially to work out the problems of the beet farmer and the sugar factory. One of the pressing needs of the industry in this country is competent and especially prepared scientific young men, who have the capacity and culture with practical experience. In the agricultural departments of California, Colorado, and Utah, the same interest is being felt and met. As the industry grows the agricultural colleges and experiment stations will furnish material for equipping these factories with the highest and best type of experts for the factory and farm. No other country has a system equal to ours for training young men in a scientific and practical way to meet the various demands of agricuture. This is the secret of our wonderful agricultural development, giving to us the leadership of the world in progressive, scientific husbandry. It is attracting the attention of other nations, and it is not uncommon to find special commissioners from them examining into the methods of our agricultural colleges and experiment stations, with a view to advising their governments thereon. The installation of beet-sugar production, stimulating as it does the best and highest scientific knowledge of factory and farm will widen the whole field of agricultural investigation.

OPPORTUNITY FOR INVESTMENT OF CAPITAL.

The wealth produced by this country is so great that our financiers have been compelled to study the resources and interests of all the other countries on the face of the earth to find avenues of profitable investment. It is a common thing to read of a company formed to exploit some business enterprise in Mexico, South America, the Tropical islands, China, Japan, or elsewhere, in fact anywhere that the restless, energetic, thoughtful American can find an avenue for investment. Often these investments are at the hazard of the peculiar customs, habits, civilization, laws, and prejudices of the country in which the enterprises are launched. The question naturally arises: "Why not exhaust our own resources for investment?" To produce the sugar we are now importing from abroad would require for the building equipment and operation of factories an investment of $750,000,000 in addition to what we have already invested. The amount to be so invested would go to our own producers for building material and

machinery, to our own laborers, both common and expert, and to our transportation companies. In order to produce this sugar, worth more than $100,000,000 annually, we would be paying out money to our farmers for beets, to laborers of the factory and farm, to coal dealers and furnishers of other supplies, to transportation companies and others. Factories would be scattered through many States, and would facilitate the distribution of money in the various localities, thus improving the general prosperity of the country.

INCREASE IN VALUE OF LANDS.

In no way are the sugar factories contributing their influence to a greater degree than in raising the money values of lands. With few exceptions the actual values of lands have largely increased immediately on the establishment of sugar factories. In some cases lands which were renting for $2 to $3 per acre, in the farming communities where factories have been constructed have brought rental values of $5 to $10 per acre, depending largely upon the location and facilities for delivering beets to the sugar factory. In the arid sections we find instances where land which recently sold at the low values given for arid grazing lands has arisen immediately upon the installation of a sugar factory to prices ranging from $50 to $100 per acre. We have an instance at Sugar City, Colo., of an expanse of wild land covering a large area without an inhabitant, which, by the aid of irrigation ditches, the raising of sugar beets, and the introduction of the sugar factory, became worth $50 to $100 per acre. The sugar company of this place had secured in a body 12,000 acres of arid lands, and it conceived the idea of growing beets on them and making them valuable. The natural source of water supply for irrigation is the Arkansas River. At the time of organizing the company, three years ago, the rights to water from the Arkansas River had been taken to the extent of the supply. This company had on its lands some natural reservoirs, known to topographers as "old lake beds," depressions which could be used for storing a large amount of water, if the same could be secured. The company secured control of a couple of lakes in the Rocky Mountains, 200 miles distant from the factory site and near the city of Leadville. These lakes were tapped and their water supply turned into the Arkansas River. Under the laws of Colorado a person furnishing water to a stream from any source not hitherto a part of its supply is entitled to take out of it at any point further along in its course the amount of water turned in less a small percentage for evaporation and seepage. The amount of water is measured, both in and out, by the State irrigation engineer. In order to get this water into its reservoirs the company constructed a ditch from the Arkansas River something like 40 miles in length, connect-

ing with the reservoirs (old lake beds) on the company's lands. In this instance, through the enterprise of this company, a large body of land was made available for growing sugar beets by bringing water 200 miles. These lands, irrigated from this supply, produce sugar beets; thus "the desert is made to blossom as the rose." Thus lands almost valueless become valuable for the production of sugar, stock, butter, cheese, poultry, etc. Where three years ago the jack rabbit and the coyote were monarchs of all they surveyed is now the center of a thriving town of 2,000 inhabitants, thrifty, prosperous, and happy in the cultivation of fertile soil and the production of finished products which give to these lands their high values.

California lands capable of general cropping and producing sugar beets are readily worth $200 per acre. Here is another instance of the influence of the sugar factory on the values of lands. It takes no inconsiderable amount of money to build and equip a factory, and once the money is invested it is of too much importance to be allowed to lie idle for want of sugar beets. From 1897 to 1901 California experienced an unprecedented drought throughout its whole extent, the beet yield ranging from a fourth to three-fourths of a crop. It occurred to those interested in the investment of so much capital in the sugar factories that something must be done to avert the effects of the drought. Deep wells were sunk, vast quantities of pure flowing water were discovered in many places, and thousands of acres were brought under irrigating ditches. Not only did these lands become more valuable, but the supply of water discovered added a valuable asset to the resources of the State for all time. Other artesian wells are going down, thus continually augmenting the arable territory subject to an abundant and perpetual supply of water.

In Idaho, Arizona, Wyoming, and Nevada many enterprises are on foot for bringing under cultivation large tracts of land hitherto considered useful only for grazing cattle and sheep. The building of sugar factories will make this land as valuable as any lands in the great agricultural States of the Mississippi Valley.

Not only do sugar factories enhance values of lands, but they are furnishing the means for payment of taxes, interest, and mortgages, making the landowner an independent freeholder, giving him better opportunities for rearing, educating, and providing for his family. This induces a higher degree of citizenship and culture and conforms to American ideals.

IMPROVEMENT IN FARMING.

The last decade has seen a wonderful transformation in the status of rural life. The farmer is no longer to be considered as following the daily routine of the quiet listless career pictured in pastoral lore; he is coming into intimate relations with the active everyday affairs

of the busy world and becoming an active participant therein. The monotony of the farmer's life is relieved by the stimulus of contact with the throbbing industrial life of the nation. He has his free mail delivery; his daily paper is brought to his door, giving him current events and daily markets; he has the telephone, and the opportunity to ride into town on the suburban street railway for a nominal sum. He is a better posted and a more competent business man than his predecessor. When we contemplate the influence and bearing this will have on the future of the farmer and his importance, we get some idea of the progressiveness of the age and the importance of the farming classes in working out the great problems of our Republic.

The sugar factory is the nucleus around which all these facilities, opportunities, and advantages gather for the most effective results. Where we get density of population coupled with the ability to thrive and progress, we have the opportunity for all these advantages. It costs about $30 an acre in humid districts and about $40 in irrigation districts to grow sugar beets. Most of this expense is for labor; hence we can readily see the large increase in the number of laborers required in a community whose leading crop is sugar beets. Where we now have large farms, from 80 acres up, we will find them cut up into smaller ones of 20, 40, or 60 acres, multiplying several times the ability of these lands to support population. The pastoral poems of the future will not so much portray the quiet serenity of rural life as the activities it presents. Such a farm life is more like suburban city life, with its advantages in the way of schools and opportunities of association.

The building up of the sugar industry furnishes more customers to the merchant and more business to the bank and stimulates business of every kind. Savings banks are more numerous and have a larger number of accounts.

INFLUENCE ON OTHER MANUFACTURING INDUSTRIES.

We often hear discussed the mutual relations existing between the farming and mining interests of the West on the one hand, and the manufacturing interests of the East on the other hand, the latter engaged in turning out the finished products required by the former, which in turn supply the crude material used by the manufacturer and food for the laborers. It is pointed out that each furnishes a market for the other and that their interests are mutual. Therefore, we should aim to develop manufacturing industries in order to furnish a home demand for the crude products of our agriculture and mining. In this connection I wish to call the attention of the manufacturers to the importance of building up in our own country beet-sugar factories, sustaining a large number of laborers on the farm and in the factory and afford-

ing a market for utensils, machinery, fuel, supplies, clothing, food stuffs, etc.

We have also concerned ourselves with building up foreign markets for our surplus products, both finished and crude. We are proud of our large export trade. I have before me the valuation of our exported manufactures for the past two years, aggregating for 1902 $403,641,401 and for 1901 $410,932,524. In each of these years steel was the largest item of export; for 1901 it was $117,319,320; for 1902 it was $98,552,562. Yet this great sum was exceeded by our imports of sugar, amounting in 1901 to $122,000,000. Consumers actually spent for sugar, both home-grown and imported, in this country in 1901 $265,664,000—nearly two-thirds the valuation of our entire exports of domestic manufactures.

Sugar is not only the most important of our imports, but it is the one which, if produced at home, is best adapted to benefit our capital, labor, and agriculture. We possess the conditions for producing all this sugar at home. If it be desirable to build up export trade in foreign countries, whose markets we must enter under all the uncertainties of competition with all the other nations of the earth, is it not vastly more important that we arrange, with conditions so especially favorable, to produce our own sugar, employing our own laborers and capital and raw material? This gives our producers the opportunity of supplying this home demand, instead of exporting to supply the needs of laborers and factories in other lands under unfavorable competition. There is probably no other article in general use the cost of which is made up so largely of labor and our own raw materials. To build up the beet-sugar industry means a more available market for all other manufactures, a market under our flag, an American market, regarded as the best in the world, open to all our manufacturers at their doors, free from competition with the products of cheap labor from all parts of the world. This is a pertinent matter for consideration at the present time. Let us produce our sugar at home, thus giving employment to an army of workmen in the construction and equipment of $500,000,000 worth of factories and another army employing $250,000,000 more of working capital in the operation of manufacturing the sugar itself. All of this is practicable. Let us seek foreign markets, but let us build home markets whenever favorable opportunities offer. Our natural conditions and resources, such as rainfall, irrigation, sunshine, and fertility of soil, the bounties of a beneficent God, appeal eloquently for utilization.

CHEAPER LIVING.

We necessarily compete with the older nations of the earth in our own markets and in those of the world against products produced by cheaper labor. It seems under our system of government, institutions,

and ideas of individual rights we are destined to do so for all time. The American principle is to rise in wages rather than decline. The aim of our institutions is toward bettering the conditions of the individual. This means a better wage and better living, a better mind, and higher culture for the laborer than in other countries. To offset the higher cost of the advantages we wish to secure and perpetuate for the individual we must produce a superior article and lessen cost of production by superior artisan ability, avoiding the lower wage scales and long hours of labor. I wish to call attention to the adaptability of the sugar industry for this purpose. It is a well-known fact that the farmer lives cheaper than most people; but in some respects he lives better; his food is fresher and more wholesome. From the nature of the case many beet-sugar factories can not be crowded together into a small area, as is the case with other factories in what are known as manufacturing centers; each must go to the locality where the beets are produced. To some extent beets are a perishable product, and freight rates for long hauls very materially add to the cost of production. For these and other reasons the factory locates in the farming area where the beets are grown. The factory stimulates meat, butter, and cheese production, and all kinds of gardening. The district surrounding a sugar factory furnishes almost everything that a man requires on his table for a good, wholesome living, and the factory workingmen can live almost as cheaply as the farmers. They have pure air, and are free from the contaminations of the congested city. This condition is much better than that of laborers who congregate in factory districts.

IMPROVEMENT OF ROADS.

Probably no other subject of interest to the rural population is receiving more attention throughout the nation than that of road improvement. One of the fundamental needs of society is a ready, practical means of communication. The experiment stations of the country are now engaged in experimental work and actual demonstration with a view to stimulating the public mind and promoting the best and cheapest systems of good road building with local material. State legislatures are enacting better laws, and in some cases the principle of State aid has been adopted. The Federal Government has established an Office of Public Road Inquiries in the Department of Agriculture. Literature has been prepared and distributed for the education of the people on this subject.

There is nothing that will work so effectually for good roads as necessity, "the mother of invention." When a beet-sugar factory is established farmers at once discover the necessity of good roads. Agitation begins, public meetings are held, and every public highway becomes the object of solicitous attention. It is found that the farmer requires at least four horses and must deliver from 2½ to 4 tons of

beets per load if he is to accomplish the best results in the saving of time and expense. Neighbors talk over road improvement, and the idea becomes infectious. A public meeting is called, public roads are discussed, and an organization is effected which goes to work for the improvement of the roads. In most instances this is accomplished even without the advantage of outside help. Among the interesting features of my work of promoting the progress of the beet-sugar industry is attendance at these local meetings, at which roads and other local subjects pertinent to the needs of these beet-growing districts are considered. Permanent road building is one of the most important matters commonly discussed.

INFLUENCE ON IMMIGRATION.

Attention has been called in recent years by the census reports to the important change that has taken place in the class of immigrants coming to the United States. Our resources and opportunities for settlement have been so great that we have encouraged immigration. The recent census reports reveal the startling information that the number of desirable immigrants from the more intelligent parts of Europe has been falling off and that immigration from the lower elements has very much increased, giving us in recent years a larger proportion of the more ignorant, vicious, disease-infected classes. This has caused us to strengthen our laws on immigration, providing against the bringing in of criminals, those liable to be paupers, and those infected with contagious diseases. As the immigrant usually becomes an American citizen, we should aim to secure the most intelligent, industrious, and law-abiding. I have observed that the sugar factories tend to draw into their service, and especially on the farms, foreigners who have had previous experience either in cultivating sugar beets or in manufacturing sugar. These people were originally drawn to this country, no doubt, by our superior advantages in general, congregating mostly in cities and towns, doing such work as they could secure as manual laborers. As sugar-beet growing increased, it presented to many an opportunity to resume the occupation in which they are most skilled, an occupation in which every member of the family can engage, down to the child of 10 years. This industrial activity of all the members of the family was the rule in the country where they came from, and it is this opportunity which appeals to them when they come here. Most of the labor in the cultivation of sugar beets comes at a time when the public schools are closed. The head of the family, for a certain consideration per acre, takes a contract for thinning, bunching, hoeing, and harvesting a crop of sugar beets, knowing that he will have use in this work for every member of his family, which is generally large. He realizes more compensation for the labor performed than he would in the country whence he came. He

acquires a good start in the world, and becomes qualified for the duties of citizenship. He and his family belong to the healthful, strong, industrial class, and soon adopt our customs, habits, ambitions, national pride, and interest, becoming excellent citizens. Through correspondence with friends in Europe, others are induced to follow their example, thus promoting a better immigration to this country. The beet-sugar factories of Europe are mainly in Germany, France, Austria-Hungary, Russia, and Sweden, and it is from these countries that sugar-beet farmers come to America.

EDUCATIONAL FORCES AT WORK IN FAVOR OF THE BEET-SUGAR INDUSTRY.

It would be hard to give a complete account of all the forces that have been operating on the public mind in favor of the beet-sugar industry. However, a brief mention of some of these various influences will not be out of place in this report. Since the aim is to foster and build up the industry, it is certainly competent to review the agencies accomplishing the results.

LEGISLATION.

Perhaps the most effective of all of these various influences at work during the last two years is public agitation incident to the consideration by Congress of sugar production, home and foreign. This has probably accomplished more in familiarizing the public with the beet-sugar industry than any other cause. Every available good thing that could be said in its favor has been made public. Every criticism that could be discovered has also been in evidence and has been thoroughly circulated. All the known advantages and disadvantages have become the common property of all intelligent readers and thinkers. Financiers know much more about beet-sugar production, and they are much better posted as to the amount of capital required for investment and the profits to be acquired thereby. The farmers throughout the country have read about the establishment of beet-sugar factories in various parts of the country from New York to California, and have a pretty definite idea of tonnage, cost of production, profits, and general benefits incident to sugar-beet growing. It suffices to say that we enter the period of 1903 with a much higher public respect and appreciation of the beet-sugar industry, a keener alertness on the part of all concerned everywhere, and a more general definite tendency of capital, business, and farming toward this industry.

THE PUBLIC PRESS.

Next in importance to the general agitation through which the industry has passed comes the work of the press. The most valuable results have been accomplished by the agricultural press, particularly

by certain papers that are devoting all their space to this one industry. Much good has also been done by journals devoted to general agriculture which are giving careful attention to this industry.

The secular press has devoted considerable space to matters pertaining to all phases of beet-sugar production. All this work is more intelligently done than formerly. This is the best evidence of general improvement of public education on this subject.

FARMERS' ORGANIZATIONS.

In sections growing sugar beets for sugar factories and in other places where the building of factories is contemplated, it is quite common for farmers to organize societies for the purpose of studying the culture of sugar beets and other pertinent questions. Papers on beet culture, covering germination, cultivation, and harvesting, and other matters of interest to the farmers, are read by those competent to furnish information on such subjects. A few years ago we could hardly find in a whole State a person who had training and knowledge sufficient to disseminate facts pertaining to this industry. The sugar factories of the country are constantly training specialists to supply this demand. The chemists and professors of our agricultural colleges have given considerable attention to the subject also, and now it is possible for any community to secure all the talent necessary, if not locally, at least within a short distance, to instruct the farmers on definite rules of culture and harvesting, and to furnish intelligent data on cost of production and profits of growing the crop. We now have in all beet-growing States local societies or unions of growers and farm laborers, county and State societies of the same, and national organizations of both. In no other field crop is so much attention given to the thorough organization of societies as in growing sugar beets. Farmers' institutes naturally take up the questions pertaining to the sugar industry, and thus we have a constant course of instruction going on, intelligently directed and effectively contributing to the upbuilding of the sugar industry.

TRAINED AGRICULTURISTS.

As a factor of education particularly affecting this industry, and indirectly the whole agricultural development, I must call attention to the employment of agriculturists by the factory organizations. The agriculturist is a person employed by the factory to superintend the growing of beets by the farmers and to arrange contracts with them providing for the factory's annual supply of beets. His relation to the farmer is largely advisory, but in some regards his directions are actually mandatory. He decides when the field of beets is ripe, issues orders to have the beets delivered, and sees that farmers comply with the various items in the contract between the farmer and the factory;

he arranges for cars, in case beets are shipped by railroad; he attends to the erection of beet dumps on the railroads in the country at available points; he superintends the crop delivery and regulations governing the tare; he visits the farmers during the preparation of the seed bed, planting, cultivation, and harvesting of the beets, and gives suggestions as to the thinning, cultivation, harvesting, etc.

In Germany the agriculturist is one of the best educated, most intelligent, and scientific men about the sugar factory. He is supposed to be acquainted with the chemical composition and the mechanical consistency of the soil, with the application of fertilizers, and the best kinds for the soil in use. He must be not only a physicist but a chemist; above all he must be a scientific agriculturist, thoroughly versed in plant nutrition and plant improvement. He is a man thoroughly posted by long, practical experience with all kinds of crops, with keeping up the fertility of the soils, and maintaining a proper equilibrium among the elements of fertility. He knows all the elements demanded by the different crops, and the proper rotation to meet the case. The sugar factories of this country are also selecting for this work the best available men; the interests of the companies require it. The work of these agriculturists serves to educate the farmers throughout the beet-sugar areas. As a permanent but less rapid source of disseminating useful information he is probably the best of all the educational forces. The usefulness of such a man in a community can hardly be overestimated. The presence and work of the agriculturist means a higher and better system of farming, not only in growing sugar beets, but in growing all crops.

Intelligence and scientific and technical knowledge are not the only requirements for a successful agriculturist. He not only has to do with the condition of plants, but he has to do with conditions of men. A mixed nationality leads to mixed traits of character. A person whose duties are so largely advisory must be one who is capable of impressing the one advised with the necessity and desirability of carrying out instructions. When his work assumes the form of actual direction, it is all the more necessary that he be a person of discretion and good judgment in administering his office. In Europe an agriculturist deals with people of his own kind, having his own habits of thought, action, and disposition, not to say instincts, which have so largely to do with our movements in life. He thoroughly understands the class of people under his supervision. The work of the agriculturist in our country is more complicated. He has to do with all kinds and classes of people, Americans and foreigners, the intelligent and the unintelligent. He must be a person of flexible character, tact, and resource in order to accomplish his purpose. The American farmer is more independent in his methods of thought and his estimate of his relation to affairs of all kinds. Even the foreigner who becomes a

citizen of the United States quickly absorbs, through his broadened freedom of action, independent ideas. Neither are subject to the same kind of oversight that obtains in the rural districts of Europe. It has been my observation that, as a rule, foreign agricultural experts employed in this country usually possess the education and scientific attainments, but fall short in administrative ability to deal with our farmers accustomed to following out their own ideas and in their own way. The agriculturist should be capable of impressing upon them the necessity of following the special rules for sugar-beet culture, and of meeting the requirements of the contracts so necessary to favorable results. An American or a foreigner who has become thoroughly initiated in our methods through long experience proves to be much more satisfactory as a rule, though usually he is not so scientific as the trained foreign agriculturist. We are rapidly developing in all of these factory districts trained men, competent to take charge of this work, equipped to meet all the conditions. I contend that the proper source of future supply for agriculturists for this industry will be found in the scientifically trained young men of our agricultural colleges who have had additional practical training in sugar-beet production. Such persons will grow up with the industry, thoroughly appreciating all of its environments, scientifically equipped to meet its problems, and practically constituted to perform his duties.

SOME RESULTS OF EXPERIENCE.

Having pointed out the agencies of education, it will be interesting to notice some of the things which have been learned.

Facts elucidated by experience are gradually correcting erroneous ideas with reference to the beet-sugar industry. As late as 1897 our own experience was derived from and limited to the few factories then in existence, most of which were in the semiarid portions of the country, only two having been established in what was known as the rain belt, these being in the east-central part of Nebraska. As sugar beets had never been grown except under rain conditions, all the available information on the subject related to the growing of beets in humid climates. This information was imported from Europe, and came as formal, lengthy, scientific discussions. Naturally, our scientists at the experiment stations studied carefully this kind of information. As a result, a very definite, inflexible, and intricate formula was announced governing the whole period of growth of sugar beets. For the people of the East, Grand Island and Norfolk, Nebr., were the objective points for practical investigation, and, naturally, it was assumed that whatever was found in vogue there must be the thing to follow in every other place where sugar beets were to be grown. These conditions led to quite a number of errors.

SOIL AND CULTIVATION.

The soil in the vicinity of the Grand Island factory is a light, loose, sandy loam. It was assumed that in order to grow beets at any other point we must have this particular kind of soil. All over the country we heard it announced that sugar beets must be grown in light sandy soil. I well remember the first serious mistake of the people of Michigan, who got the idea that their light sandy soils could be utilized in growing a productive crop of sugar beets. This idea they not only applied to their new soils, but to their light sandy soils which had been nearly exhausted by the constant growing of cereals and other crops. It was assumed that these would produce sugar beets without first restoring their fertility; but experience has shown that Grand Island was not originally an ideal selection for the location of a sugar factory, and that sugar beets, like any other heavy crop, must have the best soils to get the best results. Like corn, wheat, and potatoes, they will thrive on many kinds of soil having sufficient fertility and proper mechanical consistency. In many localities clay soil, with sufficient sand for working, is preferable to sandy loam. The sugar beet requires a fertile soil, and one in which the plant can embed itself, so as not to be forced up above the surface of the ground. It must be a soil easily penetrable by the tap root; it is through this the plant receives a considerable portion of its nutrition and especially derives its moisture, promoting its hardiness in case of drouth. It is similar to alfalfa in this respect. The set formula already referred to taught that in every instance land must be turned over to an unusual depth, and in addition thereto it must be subsoiled. Now, this is vitally necessary for a great many soils, but for others it is not; results will not pay the expense, and a sudden change from shallow to deep plowing would be harmful. In growing a crop of sugar beets on any particular piece of land the treatment must be somewhat different from that employed in growing other kinds of crops, and this treatment must be intelligently modified to suit the kind and conditions of the soil. The best information to apply in the case is that derived by experience with the land itself, obtained by growing sugar beets year after year. The great factor in future progress in this industry is the accumulation of this practical experience among our farmers.

The opportunity for decreasing the cost of production of sugar exists in two things: (1) Better and cheaper methods in the factory, and (2) the ability of the farmer to grow a larger tonnage and better beets. Working along these lines, Germany in twenty years was able to reduce her cost of sugar by one-half. I have been carefully watching the improvement in methods and results at several of our older factories. It is clear that we are going through the same process of

evolution as Germany. With experience our farmers will grow, on an average, 4 tons more per acre. They will grow beets having sugar contents at least 3 per cent higher than now. Sugar beets possessing a high content of sugar and purity not only give a larger yield of sugar per acre, but the factory can extract a larger percentage of the sugar they contain, and accomplishes the work at less expense per ton of beets. High sugar content is usually accompanied by high purity. The impurities in the beets cause the factory trouble in extracting the sugar. The farmer is gradually learning that general principles apply to sugar-beet culture only in a general way, the same as in growing other crops; they are serviceable when applied with practical experience, based on actual knowledge of the conditions affecting the particular land in question.

TIME OF PLANTING.

The old formula required planting at a particular time. Experience in the growing of other crops has shown that time of planting depends absolutely upon the season itself. Corn in Iowa is planted all the way from the middle of April to the 10th of June; the farmer has to be governed entirely by the warmth of the soil, prevalence of rain, and other conditions. It is best at times to plant early and at other times late. In actual practice we are planting sugar beets in some part of the country at almost all times of the year. Taking advantage of the flexibility of this rule of planting, time has materially aided the planters of California. A fixed time is one of the errors that has been corrected. The season is such in California that the planting of beets may occur at any time from the last of December to the first of April, and it is possible for some of the factories in that State to so arrange their planting seasons as to have beets maturing at different times, giving them a much earlier start and materially extending their campaign period. A large portion of the beets in California during the last two years were planted in January and February; several of the factories in that State were able to begin the manufacture of sugar by the middle of July, practically completing their work before the beets in Michigan, New York, Wisconsin, and Nebraska had matured. Early planting in California has materially aided sugar production in that State. The season of rainfall is during the winter months; as a rule the State has sufficient rain to germinate beets; the peculiar character of the soil is such that it holds sufficient moisture to mature the crop. This early planting induces better germination and considerable growth before the rainy season is over. It gives the beet an opportunity to send its taproot down to lower depths and thus sustain a better growth when the dry season comes on. It matures the beet earlier and gives the factory an opportunity to begin work at an earlier date.

It is clear that the rule founded upon European conditions will be found faulty when applied to agriculture under American conditions. But these are things that could only be developed by experience, and it is the solution of these problems that is making beet-sugar production a certainty.

IRRIGATION.

I have alluded to the fact that growing sugar beets by irrigation is entirely dependent upon our own experience. Extensive growing of crops by irrigation in this country is a feature of the last quarter of a century. Its application to beet culture has elucidated many facts during the last decade. The questions of when to apply irrigation and when to cease are dependent so largely upon the kind of soil and the kind of crop grown that they have to be settled largely through individual trials on each particular kind of soil. The accumulation of information as to growing sugar beets by irrigation has been rapid, and the general conclusion reached is that beets are the best and most profitable crop that can be grown by irrigation. This fact has made this crop popular throughout the arid sections of our country.

CLIMATIC CONDITIONS.

In this connection I desire to call attention to some very valuable information brought out in growing sugar beets during the past year, which apparently conflicts with the generally accepted ideas on the subject. After the establishment of the factory at St. Louis Park, near Minneapolis, Minn., the district growing the beets experienced for two years more than usual drought. All crops were materially affected. In 1900 and 1901 the drought was especially depressing. The country surrounding this factory for 100 miles in every direction is accustomed to growing principally wheat and flax, and some corn is grown. Through these two dry years other crops ran, on an average, from one-fourth to one-half a crop. Sugar beets did considerably better, reaching from three-fourths to a full crop in many cases. During this time the sugar company was having difficulty in securing sufficient acreage from the farmers for growing beets. It was able to secure only one-half to two-thirds as many beets as it had capacity to work, thus greatly reducing the length of its campaigns. The reliability of the beet crop, as compared with other crops, established during these dry years led the farmers to take up beet growing more generally, and as a result this company was able to secure sufficient acreage to produce a full supply of beets for 1902. It not only secured a full supply, but was able to select such lands as had shown the best results. Previously the factory had been compelled to go longer distances than practicable to secure contracts with farmers, even contracting with farmers in Iowa, some of them 200 miles away, for

several hundred acres. The lessons of the drought in showing the stability of beets under such conditions enabled the company to retire from distant and undesirable fields and to procure beets from better lands nearer home, thus cutting off the expense of long-distance freight charges. In 1902 this factory had an abundant supply of good beets, aggregating about 32,000 tons, running high in sugar content and purity. The farmers secured an average of over 9 tons of beets per acre. This tonnage, produced at an estimated cost of $30 per acre for growing beets, yielded about $14 profit per acre. In the cost of $30 per acre for growing beets is included full compensation for the farmer's time, the use of his teams, implements, etc., so that his profits are clear.

In this connection mention should be made of some further information gained by the experience of 1902 in Minnesota. Through this entire season excessive rains prevailed from the time the beets were planted; in the early part of the season considerable acreage was washed out requiring replanting; in a few instances the crop was lost entirely and the land was put in crops of other kinds. But, while the beet crop was affected to a limited degree in the number of acres cultivated, those harvested gave an unusual yield, while the excessive rainfall on other crops was as disastrous as the former drought. Here we have a double illustration, showing the advantages of growing sugar beets as compared with other crops under extreme drought and excessive rainfall. It is needless to say that the farmers of this locality are convinced. I was permitted to examine quite a number of letters from them to the manager, which unanimously expressed the sentiment that for that locality the staple crop should be sugar beets, and I noticed in these letters statements to the effect that the beet crop was the one on which they relied with assurance for the payment of their taxes, mortgages, interest, etc.

The conditions just described were not confined to Minnesota. The same things happened in Michigan and Nebraska. Throughout all of the Middle West excessive rainfall was the rule; nearly all kinds of crops were seriously damaged; but as a rule it was a very favorable year for sugar beets.

The results of beet growing under the excessive rainfall of the past year were apparently in conflict with a well-established belief concerning the nature of the sugar beet, namely, that in a dry season it will show a higher percentage of sugar. This belief had been confirmed by the results obtained during the two previous dry seasons when the beets were generally high in sugar content. The same thing had been observed in Nebraska during some former dry periods, as well as during the years 1900 and 1901. It was believed, on the contrary, that a wet season, especially during the latter part of the period of growth, would tend to lessen the percentage of sugar and lower the purity of

the beets. But the opposite has been shown by the results of the past wet season. Beets showed up remarkably high in sugar content and purity, though the rainfall continued to be excessive throughout their growth to the time of harvesting. I have not seen this matter discussed by our scientists, but I suggest that it is one worthy of discussion. My own opinion is this: The rule still holds good; sugar beets will be lower in the sugar content under the influence of continued rainfall during the latter part of their growth probably for two reasons: (1) The beet takes up considerably more water, causing the sugar in the beet to be lower in comparison with other contents; (2) if these rains are warm they induce a second growth of the beet, causing it to put out lateral roots and causing the inversion of some of the sugar already stored. It will be remembered that the excessive rains of the fall of 1902 were generally cold and not conducive to growth. Perhaps another explanation may be found in the fact that these continuous rains started early in the period of growth of the beets and continued throughout their growth. In many cases it was very difficult to get into the fields for the purpose of thinning and cultivating, and a great deal of difficulty was experienced from the moist, soft condition of the soil when the beets were ready for the harvest. It would be interesting to have the views of scientists as to why the crop of beets throughout the country last year showed such remarkably high sugar contents everywhere in the presence of so much rainfall, even up to the very day they were harvested.

WORK OF PROMOTERS.

The general prominence of the industry in the business world has greatly increased during the past year. Promoters are dealing more generally with the merits of the industry, and are actuated less with the hope of some extraordinary compensation in the way of bounties, bonuses, concessions, etc. We hear no longer of promoters asking large concessions or privileges, donations of land and contributions of money over and above an interest inspired by prospective values of stocks and bonds or dividends of the enterprise. A promoter nowadays is so from the fact that he has a definite proposition from which he expects to realize profits, based on the operations of the factory itself. He may be a designer, a manufacturer of machinery, or a capitalist. Through all of his negotiations appears a healthful, strong belief in the ultimate and definite paying ability of the concern he is promoting. His askings rarely go beyond the point of a location for a site, privilege of water for his factory, and drainage from it, railroad switches, other necessary conveniences, and possibly a remission of taxes for a short time. This kind of promotion carries with it more of the air of faith and inspires more of confidence.

ATTITUDE AND INFLUENCE OF RAILROADS.

I have been impressed during the past year with the changed attitude of the railroads. Hitherto they have been inclined simply to consider matters called to their attention pertaining to the establishment or operation of sugar factories along their lines, manifesting interest more in an indirect than a direct manner. It was a matter of considerable gratification during the past summer to learn that nearly all the railroad lines were giving active encouragement to the installation of sugar enterprises and helping those already built; they are realizing more the helpfulness of the beet-sugar patron, and contributing more in an active way to the upbuilding and needs of the industry. They are becoming more liberal in the matter of freight rates, which is eminently necessary, since high freights tend to restrict the beet-growing and sugar-market areas of the sugar factory. As the sugar product increases in quantity and becomes more and more a feature of railroad transportation, the railroads of necessity are becoming more alive to their relation, and no doubt in the near future will be among the most active factors in promoting the sugar industry. There are many places in the United States where the shipping due directly and indirectly to the sugar factory will be the most important item in the railroad business. In the States of Michigan and Wisconsin some railroads were originally built practically to convey the logs to the sawmills and the lumber to market. This business has been nearly completed; the roads are there but their business has very much diminished. The sugar factories will largely replace the lumber industry as a means of furnishing business for these roads in hauling the beets, coal, coke, lime-rock, and all the other crude materials used, and conveying to market thousands of tons of sugar, cattle, butter, and cheese, resulting directly or indirectly from the operation of the factories. As an indication of the effect of sugar production on transportation, I insert a clipping from the Denver (Colo.) Republican of January 30, 1903:

GREELEY, COLO., *January 29 (Special)*.—C. A. Granger, vice-president and manager of the Greeley Beet Sugar Company, to-day received a telegram from C. S. Morey, president of the company, who is in the East, that all arrangements have been made for building a railroad from Greeley into the Pleasant Valley and Lone Tree district east of town, providing the farmers of that section would contract to raise 2,500 acres of beets for the Greeley sugar factory for the coming season. This railroad is to be distinctly a beet-sugar proposition and will be handled in all its interests by the Greeley Sugar Company for the benefit of the farmers and that company.

The contemplated road is to be about 14 miles in length, and will give the farmers of one of the most productive sections of the Poudre Valley a chance to place their beets and all other products on the market at the lowest cost for transportation. The road will also open up a section of country lying to the east of Pleasant Valley which has not been extensively farmed, owing to the distance from a market.

The railroad committee of the Greeley Board of Trade is taking active interest in the road and doing all in its power to further its construction.

I notice that many of the new enterprises contemplated have as a feature the introduction of the trolley electric roads for delivery of beets. Factories already established are introducing this system of local transportation. It appears quite probable that in this way, and to supply power for other purposes electricity will play an important part in the beet-sugar industry.

CHANGE IN ATTITUDE OF CAPITALISTS.

In the beginning capital was slow in taking an interest in beet-sugar production, owing largely to the prevailing lack of information throughout the country as to the production of sugar beets. We were so accustomed to look upon the Tropics as the natural source of supply of sugar that we felt that we could not compete with the cane product on account of our high cost of labor, coupled with the necessity for high cultivation. Further investigation revealed that Europe, in the production of beet sugar, had rapidly outstripped the producers of the Tropics. Of the total sugar produced in the world in 1901, that from beets constituted 65.4 per cent. In looking for the causes which brought about this rapid ascendency of beet sugar it was found that the beet-sugar countries of Europe had rapidly reduced their cost of production through the efficiency of farmers and factory workers; that they were doing this even with fewer advantages than those possessed by the United States. They were producing this sugar on land of high value, requiring a large constant expenditure for fertilization. With our great stock interests so much benefited by the feeding products of the sugar factory, this question naturally occurred to our capitalists: "Why can not we, on our cheaper lands, which are naturally fertile, compete with the Tropics and even with Europe in the production of sugar?" Capital much quicker appreciates such advantages than any other factor in business enterprise. I think it is fair to state that capital stands in readiness to furnish money sufficient to build up this industry wherever it can be shown that the conditions are right and the farmers are ready to furnish the beets. My correspondence and observations on every hand indicate this. In studying the great number of efforts now being put forth to secure the building of beet-sugar factories I have been impressed with the fact that the work is mainly directed toward securing sufficient contracts with the farmers, assurances from boards of trade, and concessions from cities and towns regarding sites and other privileges. We have disabused the minds of the capitalists of erroneous beliefs regarding the possibilities of sugar production, which is a long step and fraught with great future possibilities.

A few years ago there were very few capitalists giving the beet-sugar industry any especial attention; those few were confined to experienced sugar producers, who had given considerable investigation to beet-sugar production. There was nothing like a general

acquaintance with the industry among capitalists. It was necessary to build the first score or more of factories and allow their bonds and stocks to go on the market in order to acquaint investors with the industry and arouse the interest of capitalists. Factory building could not proceed any faster than money was available for the purpose. To-day it is one of the aggressive agents in promoting the industry.

PUBLIC PREJUDICE.

Beet sugar, not unlike every other new product, has had to meet prejudice resulting largely from ignorance. At one time the idea was quite prevalent that beet sugar was not so good as cane sugar. While scientists and sugar experts could tell no difference between good samples of the two, the public verdict was that beet sugar is inferior for a great many purposes, such as fruit preserving, canning, etc. The scientists say that sugar from either cane or beets, when purified through refining, is exactly the same, and both are known to them as "cane sugar." But a considerable portion of the press and the people made a distinction and attributed inferior quality to beet sugar. I think this error grew out of the failure of the people to distinguish between home-made beet sugar and the imported sugar. There were times when we were using in this country a large portion of sugar coming from Europe and made from beets. This sugar readily went into consumption without question or differential in price.

In many of our new factories it is evident that first attempts are more crude than those executed after longer experience. Usually the factories begin with but few experts. The industry has expanded rapidly, and our supply of experts has been small compared with the demand. Until the machinery of such factories shall be fully adapted to accomplishing the best results and the laborers acquire efficiency in the performance of their duties it is evident that the best quality of sugar will not be placed on the market. It is also evident, as a rule, that the public is easily prepared to believe statements detrimental to a new article as compared with one to which they have long been accustomed. From both of these causes grew the criticisms on beet sugar. I think they should have been limited to the poorer productions of the home product. After its first campaign, at most, any beet-sugar factory is able to produce sugar equal in quality to any other sugar, whatever may be its source. Many of our beet-sugar factories accomplish this immediately. As a result of this popular notion home-made beet sugar has been sold at a price somewhat lower than that of other imported and refined sugar. It has been the custom for the sugar factories to offer to dealers a differential of 10 cents per hundredweight less than that of the regular refined sugar. When local factories sold their sugar to dealers at $4.50 per hundredweight wholesale this differential amounted to about 2⅞ per cent of that price and a considerably greater per cent on the actual cost of production.

THINNING AND WEEDING BEETS, NEAR AMES, NEBR.

This alone would make a good beginning for a profit account, and, based on the actual cost of production, it would be equal to at least one-third of a 10 per cent dividend. This places home producers of sugar at quite a disadvantage. The attitude of the public is materially changing on this question of quality of beet sugar, and I think it is not far in the future when home producers will be able to demand a price for their product equal to any other. They are aware now that there is no reason why they should not; it is simply a concession to public opinion and at the same time an unfair discount on a proper value of their sugar.

IMPROVEMENT IN FACTORY AND FARM CONDITIONS.

Throughout the last ten years the cost of producing beet sugar has been steadily lowered. The main thing to be kept in view in working for the future progress of the beet-sugar industry in the United States is the possibility of reducing this cost. This possibility depends on so many contingencies that the evolution must of necessity be slow. We have now 45 factories. We have passed the experimental period and have entered that of actual production.

LABOR.

Contributing to the solution of the difficulties and obstacles met by the manufacturer of sugar is the noticeable improvement of labor in the factories. Factories in operation are training schools to be drawn upon by new factories. More scientifically educated young men are drawn toward this industry. Other vocations of life do not offer young men such good opportunities. Here is a great industry, practically in its infancy, with immense future possibilities. Our young men are studying the needs of this industry and equipping themselves to meet them.

One of the first questions raised as offering an obstacle to the introduction of this industry was the lack of sufficient labor qualified to do the kind of work required in beet production on the farm. Our farmers were not accustomed, inured, or disposed as a rule to perform the hard, laborious duties required in growing sugar beets. Indeed, this was a serious obstacle. Yet as new factories have been built and the demand for this kind of labor has increased, our cities and towns, with their supply of foreign element experienced in this work, and our villages, with their young people anxious to secure some kind of employment during the vacation from the public schools, have been equal to this demand. Our own resources for laborers have been largely augmented by new supplies of immigrants, influenced by their friends to come to this country and engage in this kind of work. Our own laborers have gradually accustomed themselves to beet-sugar production and we seem eminently equipped to meet all the demands for labor. The labor supply appears to be growing faster than the demand.

TONNAGE.

We have made a marked improvement in the tonnage and the cost of production of sugar beets. This is one of the features wherein large possibilities exist for lowering the cost of producing sugar. I have noticed that the first attempts of farmers in producing a crop of beets do not, as a usual thing, produce very encouraging results; but in interviewing the farmers during the last year, in watching the comments of local papers as to results accomplished, and in observing the popular feeling generally among the growers, I find that the farmers are coming more and more to look upon sugar beets as a staple crop, and one upon which they can rely most safely under all conditions and circumstances one year after another. This changed feeling has been brought about by a generally higher tonnage, which is the measure of the farmer's returns. Experience with the crop year after year intrenches it more firmly in public estimation. It is quite common in conversation with farmers to hear them say: "I produced so many tons per acre this year, but I know I can do much better than that next year, because I have learned considerable about it." Others say, after producing the crop three or four years: "I first considered that I could not afford to grow beets; now I consider that I can not afford to abandon them." Familiarity with growing sugar beets not only results in a more regular and a higher tonnage, but in a lower cost of production per acre.

EXTRACTION.

Another thing that is very noticeable is that our sugar factories are gradually securing more and more of the sugar contained in the beets. Comparing the results accomplished by the same factories throughout a period of six years makes this very apparent. Extraction is one of the first things that an expert will look into when studying the results accomplished by any particular factory. Most of the contracts made with farmers specify that beets shall have at least 12 per cent of sugar and a purity coefficient of 80. The early results in growing sugar beets indicated that our average would not be much above this minimum requirement, but more recent results show that the average sugar content and purity are increasing, and that they will be higher than the averages obtained in Germany, France, and the other sugar-producing countries of Europe, after all their years of experience. The average of the sugar contents of the beets worked by all the factories throughout the United States last year was 14.8 per cent, and the average purity coefficient was 82.2. It is possible, with beets possessing the minimum requirements (12 and 80), to secure in refined sugar an extraction of 10 per cent of the original weight of the beets. My first investigations among the factories revealed the fact that this was thought to be about the future average extraction of the United States. This means that

an amount of sugar equal to 2 per cent of the weight of the beets is lost in the cossettes and molasses. Throughout the arid portions of the country there seems to be no great difficulty in maintaining a sugar content in the beets averaging through the entire campaign 16½ to 17 per cent; many of the beets run over 20 per cent. Now it is evident that the higher the sugar content is the more the farmer and the factory will realize from a ton of beets. If they work up beets with higher sugar content, the factories can afford to pay more per ton for them, the same as a smelter can afford to pay more for high-grade than for low-grade ore. The factory can extract the sugar from a ton of high-grade beets much more cheaply and can secure a larger proportion of the sugar. The tendency toward higher extraction is one of the best indications of improved conditions.

It has been shown that considerable sugar passes off with the cossettes or remains in the molasses. The molasses is worked and operated upon in different ways to secure the sugar it contains. When it is finally disposed of as a waste product it usually contains about 49 to 50 per cent sugar, the rest of its composition being made up of water and various kinds of salts and other impurities that originally existed in the beets or were introduced in the juice, such as lime, or were held in solution in the water entering into the process of manufacture. To obtain the sugar held in this final molasses is the ever-recurring problem of the sugar factory. Every superintendent is carefully studying all the devices for securing a more complete extraction of the sugar. Some of the older factories are installing special processes for carrying this extraction to the farthest limit. The new factories being built are quite generally installing these processes in the beginning. Several methods are used. In some factories only one of these processes is in use; in others all of them are put in operation. The leading processes are (1) crystallization in motion, (2) osmose, and (3) Steffin's. It is apparent that these additional efforts increase the expense. To secure the same amount of sugar from the molasses costs more than to extract it from the juice. The factory can afford to carry the process to the point where the cost of securing the sugar equals the value of the sugar extracted, but no further. All our factories are working toward higher extraction and are obtaining favorable results, gradually lessening the quantity of sugar left in the molasses and the cost of securing the sugar from it.

USES OF BY-PRODUCTS.

As the uses and value of pulp as a food for stock are discussed at length in another part of this report, it need only be mentioned here as the most important by-product of the beet-sugar factory.

The molasses is a by-product of considerable utility, but not so important as the pulp. Originally it was an actual obstacle in the way

of the factory, requiring some expense to remove. It is now receiving attention from various sources to discover in what manner it can be most practically and profitably utilized. In the older countries they use it as a raw product in the manufacture of vinegar, alcohol, shoe blacking, and fertilizer. Different factories make different uses of the molasses. The most practical and profitable use of it at present is in making alcohol. A chemical company in Bay City, Mich., is arranging to handle large quantities of this molasses in the manufacture of alcohol. It is claimed that the alcohol produced from it is superior in quality to that ordinarily found in the markets. This company is contracting with several factories in Michigan and other States to use their entire output of molasses, and it is said that other companies are forming, some with a view to working up this product in the manufacture of alcohol, and others for manufacturing vinegar from it.

METHODS OF CULTIVATION.

Improvements in methods of cultivation and knowledge of correct principles of agriculture are important results from the establishment of the beet-sugar industry. The science of meteorology is probably founded mainly on the results of actual observations. Certain effects have been observed to follow certain phenomena. A long record of such occurrences makes it possible to establish rules upon which many of the predictions of the Weather Bureau are based. The longer the period of observation the more certain become its predictions. This illustrates the manner in which we are accumulating facts with reference to beet culture. Every farmer is an observer. The sugar-beet crop is practically new, and the cultivation of it is practically one of trial. We are building up a mass of definite accurate information as a result of these trials. We know that sugar beets are a profitable crop in themselves. We know that beet-sugar production contributes benefits to agriculture. We are learning that the thorough cultivation, deep plowing, minute pulverization of the soil, and more nearly complete destruction of weeds add much to the condition of the soil itself. Sugar-beet culture is practically garden culture (Pls. I and II). A sugar-beet crop responds readily to intelligently applied fertilizer: above all it meets the expense of fertilization. A piece of land is brought into a much better condition for all kinds of crops after it has been used for a period in growing sugar beets. The crop naturally leads a farmer to the habit of more intense cultivation because the results are so apparent. He appreciates more the rewards of laborious effort intelligently applied. He rotates sugar beets with other crops and finally brings his farm to a high state of cultivation and learns their value in comparison with other crops.

SUGAR-BEET PULP AS ANIMAL FOOD.

Since early attempts in agriculture during the first settlement of the country few things have occurred of so much vital importance to the agricultural interests as the installation of the beet-sugar industry.

The advancement of modern science and its application to the development of the industries of the country is one of the marked features of our short history. Agriculture was slow in securing the benefits of scientific discoveries, but recently there has been a great general awakening in all the branches of agriculture. It is attracting the best thought of the chemist, physicist, the manufacturer, and financier. To-day the agricultural resources are strongly and favorably competing with all other branches of industry for capital to finance its various enterprises. There is no question but that the scientist, the financier, and the press are in advance of the farmer in appreciating the financial benefits of the sugar industry to all agricultural interests.

The farmer has a twofold interest in the development of the beet-sugar industry, both in his own section and in general throughout the United States: First, it calls for an immense amount of capital, labor, and raw materials of many kinds, and thus creates a demand for every kind of product that is grown on the farm; second, it supplies the farmer a cheap and valuable stock food.

WHAT IS SUGAR-BEET PULP?

Sugar-beet pulp is the residuum left after extracting the sugar from the beet. It is to the sugar beet what oil cake and oil meal are to the flaxseed. It is a by-product of the factory, the same as brewers' grains is a by-product of the brewery, or gluten feeds of the starch factory. The oil cake and oil meal, and the by-products of the brewery, the distillery, and the starch factory all have a commercial value as feeds for stock; but I wish to call attention to the advantages possessed by sugar-beet pulp. In the first place, the breweries, distilleries, starch factories, and linseed-oil mills are all located at manufacturing centers, and far distant from most of the farmers, and for this reason their by-products are not generally known by farmers and feeders. The raw material that these factories use, such as flaxseed and grains of various kinds, are shipped by rail from considerable distances for the purpose of being worked up. But the sugar factory must be built in the midst of the area which supplies it with raw material; for this reason the supply of pulp is immediately available at little expense to the farmer, it being possible in most instances for the farmer to deliver to the factory a load of beets and take home with him a load of pulp; or, if he lives at some distance and his pulp must be delivered by the carload lot, he has a short freight haul which does not add very materially to the expense.

In 1901 we imported from foreign countries sugar to the valuation of $122,000,000; the wholesalers paid about $159,000,000 for it after it was refined; the people actually paid for this imported sugar when it went into consumption about $196,000,000. It is safe to say that

for imported sugar and home-made product the people paid about $225,000,000. Several countries[a] in Europe have developed large interests in beet-sugar production, and, partly to supply the demand for sugar in this country, some of them sufficient to furnish at least two-thirds of our consumption. In doing this they have become large producers of sugar-beet pulp, and for a long time they have had to give considerable attention to the question of feeding it.

In Germany, France, Austria-Hungary, and Russia pulp as an article of commerce is as staple as corn, oats, barley, rye, or hay in this country. There is nearly as much written about it in the agricultural press of those countries as there is about the sugar itself. If it should be eliminated or the supply cut off for some reason, the feeding and dairy interests of those countries would be seriously affected. If, after the farming community around each factory has supplied its needs, there is a surplus of pulp, it is put through a drying process and placed on the markets for general consumption. Pressed pulp, like turnips, mangel-wurzels, rutabagas, and sugar beets themselves, is a very succulent food, containing about 85 per cent of water. After going through this drying process it comes out thoroughly dry, in flakes, the water content being reduced to about 5 per cent of the whole. Dried pulp as a food is, therefore, a great deal richer in nutritious elements, pound for pound, than the original pressed pulp. This drying of pulp makes it possible to preserve it for a long time and to ship it long distances at a minimum of expense. In the countries mentioned dried pulp is sold at the feed stores the same as bran and oil cake in our own country, and almost every person owning an animal, whether living in the country or in a village or town, is a consumer of pulp.

Unfortunately our people are not experienced in the use of pulp. As a result, some of our factories are unable to dispose of their supply and many of them dispose of it for a very small consideration. Some factories are compelled to give it away or dump it out on some available waste spot or into bayous or rivers, using any practical method to get it out of their way. This is the present status in regard to disposal of pulp in this country. The time is coming when this pulp will gradually win its way into favor and become one of the staple articles of commerce. The farmers around our sugar factories will see the opportunity it affords for rearing animals of all kinds and its availability for supporting creameries and dairies, and whatever surplus pulp remains over at any particular factory will be dried and put on the general market.

To illustrate how much knowledge and experience has to do with the demand for any article of public utility I will cite the experience of the factories in New York. The farmer of this State had been

[a] All European countries produce sufficient sugar to meet their own consumption except England, Portugal, Greece, Switzerland, and Turkey.

schooled for years in intensive agriculture. In competition with the Western farmer he found the necessity of feeding his crops and putting on the market such products as meats, poultry, eggs, butter, and the like. He was accustomed to feeding the by-products of the distillery, the starch factory, and the brewery, and when the sugar factories were installed he naturally took to pulp feeding as a matter of course, and the factories in that State were able to dispose of their pulp immediately at $1 a ton. A similar experience, and for the same reason, was had in Wisconsin. In Michigan the lumber interests had been very extensive and agriculture was in a somewhat backward state of development. The sugar factories were installed so rapidly and in such numbers that no profitable disposition could be made of the pulp. It was sold at a very low figure, given away, or thrown away. These Michigan companies have found that they will have to wait patiently until the people of the State become better acquainted with the use and benefits of pulp feeding. And this is taking place surely if not rapidly. Farmers are beginning to utilize pulp, and the factories are able to dispose of more at some price; and now we hear on every hand of new feeding and creamery enterprises stimulated by this useful article of food.

I desire in this connection to correct a common error that seems to have gotten into the minds of the people generally who have no acquaintance with pulp. Many seem to think that beets are boiled or ground and pressed in the process of sugar extraction. This is not true. The raw beet is simply cut into long, slender, grooved slices. In the factory these slices are known as cossettes. The cossettes are placed in large steel air-tight cylindrical vats and immersed in hot water, which is under pressure, but not in such a way as to crush the cossettes. Fourteen applications of hot water are made in this way to the same lot of cossettes, and in this manner the sugar is dissolved out of the beets and carried off in the water when it is drawn off. This watery solution of sugar and the salts extracted from the beets is evaporated in the sugar factory, and the cossettes themselves come out practically in the same form they went in. They are conducted out by carriers, put under a certain amount of pressure, and are then ready to be placed in the pulp silo or to be taken away for feeding. Where pressure is applied, as just indicated, the product is known as pressed pulp. If not pressed the pulp will retain a higher percentage of water.

SUGAR BEETS, BEET LEAVES, AND BEET PULP COMPARED FOR FEEDING QUALITIES.

Sugar beets are extensively grown in all European countries, along with other root crops for feeding purposes. The experiment stations throughout the United States have given considerable attention to the

growing of this crop strictly for stock food. The Iowa State Experiment Station, located at Ames, found that from 25 to 28 tons of sugar beets per acre could be grown, and even more in some instances. The beets were also found to be a very desirable stock food. It does not require nearly so much labor and expense to grow an acre of beets for stock as it does to grow an acre of beets intended for the sugar factory. In order to grow beets for factory purposes certain results must be obtained in the constituent elements of the beets. In the first place, they must be high in sugar and low in certain salts, known as impurities. Everything depends upon the quality and purity of the beets so far as their usefulness to the sugar manufacturer is concerned.

These qualities are not required in the case of the larger or stock beets. It is found that sugar beets must be held down to a certain maximum in weight in order to get the quality and purity. This is not true of the stock beets; hence, the farmer can produce considerably higher tonnage when growing simply for stock. Sugar beets are a profitable crop to raise for feeding along with grains and other stronger foods. By experience any farmer realizes at once the value, quality, and cheapness of sugar beets grown for stock. I have constantly urged this point throughout my reports on progress of the beet-sugar industry. The farmer not only realizes the advantages of raising a crop of beets, but he also becomes more familiar with the habits of the plant and the general nature of the crop itself. I have urged that a general production of sugar beets for stock purposes would be beneficial to any community, and where a factory is liable to be established such production tends to educate the community in regard to the germination, cultivation, and harvesting of the crop. In such case the factory is not required to begin, as is usual, with everybody in ignorance of the requirements.

I wish to insist on the desirability of raising sugar beets for stock food under any circumstances, but of course there is less necessity for growing sugar beets for stock in a locality where a sugar factory is in operation. Sugar beets and sugar-beet pulp have about the same value, ton for ton, for feeding purposes. The farmer who takes a ton of beets to the factory and brings back a ton of pulp has really brought back about as much feeding value as was in the beets he delivered; and, while he obtains only one half as many tons of pulp as he delivers tons of beets to the factory, it only costs him about one-fifth to one-third of what it would cost to grow the beets producing the pulp. When he delivers beets to the factory and takes home the pulp, he has left most of the sugar and considerable of the water and salts which the beets contained at the factory, the bulk of the original elements making up the feeding qualities of the beets being still in the pulp. Sugar is not to be classed as one of the valuable feeding qualities of the beet. Sugar is made up of oxygen, hydrogen, and carbon, or, as a famous

chemist used to express it, "The sugar in the beet is composed of air, sunshine, and water." Practically the sugar in the beet comes from the air, while the main feeding qualities of the beet come from the soil. Thus the farmer can readily see that, if there is a sugar factory where he can get pulp, it is much cheaper and better in every way to procure pulp than to grow sugar beets for feeding purposes. He can grow beets and sell the sugar out of them to the factory, and still have left the greater part of the feeding qualities of the original beets at a comparatively small cost. This, then, should be the rule: The farmer who is not near a sugar factory should grow sugar beets for stock food, because they are a cheap, valuable, and healthful food for animals; the farmer who lives in the locality of a sugar factory should grow beets for the factory, and use the pulp from the factory for feeding purposes.

Beet leaves are also used extensively for stock food in European countries and in sections of this country where we have beet-sugar factories. It is probable that beet leaves make a better food than either sugar beets or beet pulp. In harvesting the beets the leaves with a part of the crown are clipped off by a stroke of the knife and allowed to fall in piles or windrows in the fields, where they are cured by the action of the air and sun, the same as hay. They are then hauled out and fed or put up in mows like hay. In European countries they are especially prepared by a process known as drying, the same as with pulp, which is accomplished in kilns, and the dried leaves are sold in the markets for stock food. I have conversed with a great many farmers and scientists on this subject of using the leaves for feeding purposes, and, while nothing can be said other than favorable as to the quality of beet leaves for stock food, whether cured like hay or dried and put on the market, yet it is an open question whether or not they should be so used. In performing their function in the growth of the beet they store up considerable valuable fertilizer, and if left on the ground increase the humus and contribute materially to the fertility of the soil. It is clear that if the leaves are taken off the ground its fertility must be kept up to an equal extent by using some thing else to supply the deficiency. This entails expense and labor. It is simply a question of whether the leaves will accomplish more for feeding or for fertility. The consensus of opinion among the people I have consulted on the subject appears to be that it is better to let the leaves remain on the ground until such time as all barnyard fertilizers are utilized.

I presume it has occurred to the practical farmer in reading this discussion that the growing of sugar beets for whatever purpose stimulates an increase of animals on his farm, and offers him an opportunity to keep up the fertility of his soil. It is a common observation in many places throughout the United States that much of the farming

is accomplished without the proper balance between the animal and the crop side. For instance, take the small-grain sections. We are always confronted with the idea that we can not go on forever removing these crops from the fields, leaving practically nothing to restore the fertility of the soil. The farmers in such sections do not keep sufficient stock to furnish enough barnyard manure to keep up the fertility of the soil. Sugar beets, whether raised for stock or for the factory, improve the conditions. They enable the farmer to grow grain and at the same time encourage him to support a large number of animals, which in turn are giving him back in barnyard manure the elements of soil fertility. He raises a crop and sells the sugar to the factory, feeds the nutritive portion of his crop to his stock, sells his stock at a profit, and returns to his land in the manure the fertility taken from the soil by the crop.

KINDS OF PULP.

In connection with pulp feeding, it is necessary to discuss the kinds of pulp. We have fresh (unpressed) pulp, pressed pulp, siloed pulp, and mechanically dried pulp. Fresh pulp is that directly from the diffusion battery, containing from 90 to 94 per cent of water. Pressed pulp is that which has been run through a press which removes a portion of the moisture; it contains from 85 to 90 per cent of water. Siloed pulp, or old pulp, is that which has been held over and in which certain changes have taken place; that is to say, it has soured, and corresponds somewhat to ensilage. Dried pulp is produced by taking the pressed pulp and running it into kilns or cylinders, where it is subjected to a high degree of heat while being constantly agitated. It comes out in a very flaky dry state, containing only about 5 per cent of water.

The question naturally arises, What kind of pulp is the best to feed? This is entirely dependent upon circumstances. If you are a farmer in the vicinity of a sugar factory, in all cases and by all means use the pressed pulp. If you are a farmer at a distance from the factory or living in a village or city, the best kind of pulp for you to use is the dried product. I shall aim to show further along that there are certain mechanical reasons why the pressed pulp is best under the same conditions and advantages for using either. A person living at a distance from the factory can not afford to pay for the transportation of so much water as is contained in pulp fresh from the factory.

The fresh pulp and the fresh pressed pulp are very much alike in composition, the main difference being that the pressed pulp contains from 5 to 10 per cent less water. Both have the advantage of succulency, but it has been found by experience that the fresh pulp is too moist. As the pressed pulp contains less water, it is correspondingly more valuable as food for stock. Pressed pulp is therefore to be preferred and most factories are prepared to furnish it.

Some factories being unable to dispose of the pulp, have to resort to the cheapest method of getting it out of the way. In such instances it is often floated out with water to the place of its destination and not required to pass through the presses at all. Other factories convey the pulp directly from the diffusion batteries to the cars or other receptacles, not pressing it, but allowing it to drain. Such pulp contains considerably more water than that passing through the presses.

If fresh pulp contains 90 per cent of water (which is the minimum), a ton of it will contain 200 pounds of dry matter. If ordinary pressed pulp contains 85 per cent of water, a ton of it will contain 300 pounds of dry matter. In Germany they are able to apply a pressure that furnishes a pressed pulp containing only 80 per cent of water; such pulp would furnish 400 pounds of dry matter per ton. It is evident that the farmer should prefer to buy pressed pulp. In Germany where the factories are able to dispose of their dried pulp they receive for the same $1 per hundredweight, or $22.40 per ton. It is apparent that the value of this dried pulp is due to the very large proportion of dry matter it contains. Such pulp is preferable on account of its condensed form for shipment to a distance, and this widens its market. It is valuable to the extent of the nutriment it contains, but loses some of the advantage possessed by the fresh pulp in its mechanical and sanitary effects.

BENEFITS OF FEEDING PULP.

The feeding industry of the United States has grown up, like many other things, on the principle of giving the most attention to quantity rather than quality, trying to accomplish the most with the least effort. In coming in competition with foreign-fed meats, such as mutton and beef, especially from England and Scotland, our feeders realize that in order to place the American meats, butter, and cheese on the tables of the foreigners, they must not only produce quantity at low cost, but must also produce quality. It was the discovery of this fact that led our intelligent successful feeders to investigate the cause contributing the fine quality and flavor of the English and Scotch beef and mutton. We were capable practically of supplying the needs of the world with meats, but, though there were exceptions, feeders as a class had not reached that high degree of excellence in quality and flavor obtained in those countries.

In meat production it was found that England and Scotland fed, along with their dry forage and grain, considerable succulent feed, such as turnips, mangel-wurzels, sugar beets, and rape. This induced the agricultural experiment stations throughout the United States to begin series of feeding experiments, using rations composed of ordinary dry feeds and succulent matter. They have published to the

world the results obtained, with the effect of greatly modifying our whole system of feeding for meat production. A food ration is recommended containing a good supply of these succulent feeds as absolutely necessary to a high degree of excellency in a steak, chop, or roast. We are able to supply even the English not only large quantities of meat, but large quantities of the best meat, competing with her choicest production. We are able to compete with the best meat-producing districts of England and Scotland by feeding rape, sugar beets, mangel-wurzels, and other succulent crops with our concentrated feeds, our cereals, and dry forage.

Sugar beets and pulp offer to every feeder of sheep, cattle, horses, hogs, or milch cows a useful succulent feed for stock rations producing this high quality of animal product, as has been shown through these tests.

I have tried to set forth clearly and distinctly the results to be accomplished in feeding pressed pulp. The question naturally arises, "Are these results obtained on account of the nutritious qualities of the pulp alone?" I will have to answer, "No. Sugar-beet pulp is not valuable solely on account of the nutrients it contains, though in this respect it is directly comparable with coarse fodders. The animal could not be fattened on pulp alone; indeed, it is doubtful whether it could be successfully reared or sustained for a considerable length of time. It is found that the benefits of pulp feeding result largely from its mechanical and sanitary effects." Our feeds have consisted largely of the cereals and dry forage; the addition of this pulp to the ration appears to aid materially the digestion of the other foods. I have often asked men who are extensive feeders of pulp, "What is the comparative commercial value of pulp?" I have always been informed in reply to this question that "no chemical analysis can give the value of sugar-beet pulp. Its value does not result so much from its nutritive qualities as from its aid to digestion and the general healthful tone which it gives the animal itself. We practically feed as much of grains and other forage in a ration as we would without pulp; gains are not accomplished on the saving of grain in a daily ration, but they are accomplished in the rapidity with which the animal takes on flesh and gains in weight, cutting down the total requirement."

Mr. John Remers, of Grand Island, Nebr., who has been a large feeder of steers for years, puts it this way: "I feed about as much grain and hay with the pulp ration as I did without, but I put them on the market in three-fourths of the time." He called my attention, in walking through his feed yards, to the entire absence of grain and other feed in the droppings in the barnyard, showing that the animals were completely digesting what was fed. I give it as the general verdict of feeders that the benefits of pulp result from the more nearly complete digestion and assimilation of the nutrients in the ration; and

that the superior quality of the meat itself comes through the healthful tone of the organs of the animal, which are able to perform their work evenly and perfectly, and therefore produce superior meat.

HOW TO FEED PULP.

It is found that in fattening any kind of an animal where pulp enters into the ration, a full supply of pulp should not be furnished immediately; the animal must be allowed to adjust itself to the new food. The best practice in all cases of fattening is to begin on a small amount of pulp, say 40 pounds per day for a steer, and gradually work up to 80 pounds per day, and then gradually work down again to 40, giving the animal a chance to "finish" or to harden in flesh. Milch cows may be gradually worked up from 20 to 40 or 50 pounds per day, and this amount kept regularly in their diet. Fattening lambs or sheep are put on from 1 to 2 pounds and gradually worked up to 7 or 8, gradually diminishing to the minimum with the "finish." Mr. Remers claims that he can put all kinds of stock on their full feed with pulp quicker and that they will eat damaged roughness better with pulp than in any other way. The tendency of pulp is to act as a laxative; it is lacking in ash and has a large quantity of water, so that the digestive apparatus of the animal must be allowed to adjust itself to the new food.

Mr. Allen, secretary of the Standard Cattle Company, probably one of the largest cattle and sheep-feeding concerns in the country, has had considerable experience in feeding pressed pulp. Near his feed yards is a large beet-sugar factory, capable of working up 500 tons of beets per day, and producing about 250 tons of pulp. He fed last year about 33,000 head of sheep. I examined the flock at the time he purchased them, in company with one of the best sheep experts in the United States, who pronounced them an ordinary flock. They were given the regular ration of grain and hay, and in addition pulp. When they were sold he topped the market with this bunch, or the most of them. This indicates that it is possible to take an ordinary flock of sheep and make out of them the best marketable meat, a product that would compete with the English mutton. Mr. Allen fed a large bunch of sheep the year before, and in this connection I quote his feeder as to how and what he fed them:

> The pulp is the usual diffusion pulp, loaded when fresh onto the cars at the factory and used immediately.
>
> The surplus pulp produced by the factory over what we could use was unloaded from the cars at convenient points on the railroad into large piles alongside the track and thus left until used. About 10 to 12 inches of the outside of the pile decayed and formed a dense mass which made a silo for the remainder, keeping it in very good condition. We are now using pulp that has been kept in this way for about two months, and it is all right.
>
> The pulp is fed in troughs similar to the troughs ordinarily used in sheep feeding, but somewhat deeper, so as to hold the amount of pulp necessary. The pulp is first

scattered in the troughs and the grain scattered on top of it; afterwards they are mixed thoroughly. The sheep are fed twice daily.

We commenced feeding pulp by giving 1 pound per head per day and mixing this with a grain ration which at that time amounted to 0.9 pound for lambs and 1.1 pounds for sheep. We gradually increased the pulp ration until it reached between 9 and 10 pounds per head per day for sheep, and between 7 and 8 pounds per head for lambs, which was about all they would eat.

As to the value of pulp as compared with other feed, I have no accurate data. I think it requires less time to fatten and consequently less grain. In this way on a full ration, such as would be used without pulp, I believe sheep will fatten in considerably less time, which will result in a decrease in the amount of grain used, and I also think that a heavy grain ration can be fed with greater safety when using pulp.

We have not experimented. On December 12, 1899, we put somewhat over 16,000 sheep into our barns and fed them on a ration of ensilage and grain with plenty of hay until the factory provided us with pulp, which was about the 10th of January. We then commenced using the pulp as herein stated and have had very satisfactory results.

In feeding pulp a liberal supply of salt should be used, as the results are always shown to be beneficial.

SCIENTIFIC EXPERIMENTS IN PULP FEEDING.

In seeking for actual facts as to the feeding value of any particular article entering into the food ration of stock, especially if it be a new and untried one, we naturally turn to the State experiment stations for their conclusions. These stations are the high court of appeal on all mooted questions in agriculture. They are undoubtedly one of the most beneficent of all the helpful things the National Government has devised to foster and develop agriculture in this country. I will present the results of work done by the experiment stations of three States—Colorado, Michigan, and New York. Colorado and Michigan have developed considerable interest in beet sugar and at the same time are beginning a healthful improvement of their stock interests. New York is becoming interested in a less degree in sugar production from beets, but the State has a great interest in stock feeding and dairying.

EXPERIMENTS IN MICHIGAN.[a]

I will first consider the results of work at the experiment station in Michigan, under the directorship of Prof. Clinton D. Smith. He recently concluded two experiments in feeding pulp, in which the objects of the feeding were for different purposes. Below I summarize his report on the same:

The first was an experiment conducted on the farm of the Hon. A. W. Wright, near Alma, Mich. He had several hundred head of steers, thin in flesh; he had plenty of cheap pasture for grazing in the summer; his object was to carry the cattle through with as little outlay as possible until his pasture was available; he had plenty of other

[a] Bul. 193, Michigan Expt. Station.

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feed, but it was not of the best quality; he had barns and sheds and furnished all the feed necessary for the experiment, which was conducted under the direction of the State experiment station. The steers used in the experiments were divided into two lots as much alike as possible. The first lot was fed a daily ration made up as follows: Pulp, 55 pounds; mixed hay, 8.5 pounds; shredded corn stover, 4 pounds; ground grain, 2.4 pounds. The daily ration of the second lot was: Mixed hay, 11.5 pounds; shredded corn stover, 8 pounds; grain, 11.5 pounds. It will be noticed that the second lot was fed only grain and ordinary forage, while the first lot was fed the same and in addition sugar-beet pulp. The results were as follows: The lot of steers receiving pulp in their daily ration made an average daily gain of 1.42 pounds. The lot receiving no pulp made an average daily gain of 0.684 pound. Director Smith in his report on this experiment says:

> Comparing the amount of food consumed by each pen to produce the net pounds gained and computing from this data the value of a ton of pulp as an additional succulent fodder, the tests show that under the conditions existing a ton of pulp fed with other factors in the ration took the place of 421.5 pounds of corn stover, 274 pounds of mixed hay, and 68.8 pounds of grain.

He calls attention to the fact that the grain and forage fed to these two lots of cattle were not of the best quality, and, while the pulp-fed steers made remarkable gains over the others, it must not be taken as absolutely proven that this would have happened had the food ration of the second lot been of the best quality. He also calls attention to the rule of scientific experimenters that the result of no single experiment must be taken as establishing definite facts; such experiments should be repeated before accepting the results as conclusive.

The station conducted a second feeding experiment on the farm of the Hon. A. M. Todd, of western Michigan, who had a large number of steers in poor condition. It was the purpose of this experiment to fatten as rapidly as possible. The station supervised the feeding in this instance as in the other. The steers entering into the experiment were divided into two lots as nearly equal as possible. The first lot received a poor quality of mixed hay and in addition wheat bran, oats, and corn meal. The second lot received the same ration and in addition beet pulp. The results of the experiment were as follows: The first lot receiving no pulp made a daily gain of 1.84 pounds. The second lot, to which pulp was fed, made a daily gain of 2.25 pounds. In order to establish a ratio of comparative values between pulp and the other items of food which entered into the ration used, I give below the results as determined by Director Smith:

> Making the computations as before to find the estimated value of a ton of pulp, we find that under the existing conditions at Pearl (Todd's farm) a ton of pulp took the place of 244 pounds of mixed hay, 32.6 pounds of wheat bran, 296 pounds of corn meal, and 27.2 pounds of oats.

A third experiment was conducted also on the farm of Mr. Todd, in which two lots of steers were fed the same kind and amount of dry feed for six weeks. To the ration of the one lot pulp was added. The feeding of 13,775 pounds of pulp gave an aggregate increase gain to the steers so fed of 280 pounds. Counting the beef worth 5 cents per pound, it gave the pulp the value of $2.03 per ton.

EXPERIMENTS IN COLORADO.[a]

This State has become intensely interested in beet-sugar production, and is also building up considerable interest in lamb and general stock production. The experiment station located at Fort Collins, under the directorship of Prof. L. G. Carpenter, has been conducting feeding experiments with sugar-beet pulp. Without going into the details of the experiments themselves, I give some of the results obtained as set forth in the report of the director. It was demonstrated that sugar beets and sugar-beet pulp were equally valuable for feeding pigs. Pulp may be very profitably fed to growing pigs in connection with the grain ration. The value of the pulp, measured by the results of the experiments, indicates that pulp costing $1.50 per ton may be fed to good profit. Satisfactory results were secured when pulp was fed in combination with grain. Pulp served the same purpose in a hog ration as did sugar beets and at less expense. It is not advisable to feed more than 2 pounds of pulp in weight. The experiments indicate that hogs derive some nutrition from beets or pulp, but the principal use seems to be mechanical. Beet pulp is a valuable roughage for lambs fed with alfalfa; pulp-fed mutton has good flavor. Pulp fed with alfalfa made gains at the least cost per pound and gave the largest profit. The second best profit was from lambs which were fed with spelt and alfalfa. The third best combination was beets and alfalfa with a ration of grain, gradually decreasing the amount of beets in the ration toward the end of the feeding period. Pulp should be gradually diminished during the finishing period. Sugar beets were not as valuable as pulp for lambs.

EXPERIMENTS IN NEW YORK.[b]

The experiment station at Cornell, N. Y., conducted an experiment in order to ascertain the nutritive value of the dry matter in pulp in comparison with the dry matter in corn silage. It was found that they were equal. To furnish the same amount of dry matter it took twice the quantity of pulp as of the silage.

While it must be conceded that we should not base positive conclusions on a single set of experiments, here are several sets of experiments, conducted at different experiment stations, all giving strong

[a] Bul. 74, Colorado Expt. Station.

[b] Bul. 183, New York (Cornell) Expt. Station.

evidence on the one point, namely, that sugar-beet pulp is a desirable, cheap, and valuable food for stock of all kinds.

INFLUENCE OF PULP FEEDING ON LIVE STOCK AND DAIRY INDUSTRIES.

I presume it is patent to the reader of this article on pulp, in the light of the experience of European countries and the tendency shown in our own limited development of the industry, that pulp feeding will have a remarkably stimulating influence on the agricultural interests generally. In the States of the Rocky Mountain region and the Pacific coast, live-stock industries have been greatly stimulated by the production of alfalfa and the use of sugar-beet pulp from the sugar factories of these States. In all these States where the beet-sugar industry has taken hold, active development of the dairy industry may be observed. Colorado, Utah, and California will soon be contributing to the general consumption considerable dairy products, in addition to supplying their own demands. Wisconsin is already one of the leading dairy States of the Union. There is a sugar factory in that State at Menominee Falls, and a prospect for three or four being in operation in other parts of the State in 1903, while at a dozen other places active steps are being taken for the installation of factories no later than 1904. The large dairy interests of Wisconsin will find in these sugar factories their strongest allies in producing the best and cheapest product. In Michigan we have the reverse of these conditions. This State has a large number of sugar factories already in operation and is beginning to establish dairy interests which should grow rapidly under the stimulus of the sugar factory by-product.

PRESENT PULP POSSIBILITIES.

In pursuance of the claims made for pulp as a food for animals, I will introduce an estimate of the pulp product[a] of the United States and the number of animals which might be fed thereon. In this estimate I shall use the three States having the largest interest in the manufacture of sugar from beets, and close with the total production of pulp in the United States. I shall use as factors in this estimate the combined daily capacity of the factories now in existence, the average length of campaign (eighty-eight days) which the factories operated through the United States in 1901, the pulp to be fed in a balanced ration along with other feeds, 50 pounds of pulp to be fed daily to each milch cow during the entire year, an average of 50

[a] The figures given in this estimate are much higher than the actual production, owing to the fact that scarcely any of the factories have ever been able to work to their full capacity because of short supplies of beets. The quantity of beets actually worked by all the factories in 1901 was 1,685,688 tons, being about half the present estimate.

pounds of pulp daily to each steer during the fattening season of six months, and an average of 5 pounds to each sheep or lamb during the fattening season.

Michigan would produce 1,100,000 tons of beets, which would yield 550,000 tons of pulp. This pulp would feed 60,280 milch cows, or 120,560 steers, or 1,205,600 sheep.

California would produce 928,400 tons of beets, or 464,200 tons of pulp. This pulp would feed 50,223 milch cows, or 100,466 steers, or 1,000,000 sheep.

Colorado would produce 391,600 tons of beets, or 195,800 tons of pulp. This would feed 21,459 milch cows, or 42,918 steers, or 429,180 sheep.

The United States would produce 3,281,040 tons of beets, or 1,640,520 tons of pulp. This would feed 179,798 milch cows, or 359,596 steers, or 3,595,960 sheep.

The Michigan experiment station demonstrated that a ton of pulp would produce 41 pounds of beef, live weight. At this rate the total annual pulp product of the United States would produce 67,261,320 pounds of beef worth, at 5 cents per pound, $3,363,066. Not over 10 per cent of this utility is realized at present.

The disposal of the pulp produced by the beet-sugar factories is a question receiving considerable attention throughout the United States, especially in localities where farmers are not experienced in the use of by-products in their stock rations. The industry is developing so fast, and in some quarters the information with reference to the value of pulp is so limited, that the factories are finding it difficult to make any profitable disposal of this by-product. This affects seriously the earning power of the factories.

In the Colorado experiments already cited it was demonstrated that pulp costing $1.50 per ton can be fed at a profit. If we accept this valuation of pulp, throwing it away means a loss to the factory of 75 cents on each ton of beets worked, or at least 15 per cent of the purchase price. If, as demonstrated in the Michigan experiment cited, the addition of pulp to the ration produced $2.03 worth of beef for every ton of pulp fed, the feeding of pulp costing $1.50 will yield a profit of 33⅓ per cent. The New York experiments demonstrate that two tons of pulp are equal in value to 1 ton of ensilage. The farmer who knows the feeding value of ensilage can draw his own conclusions as to the value of pulp.

In this connection I take from a publication known as the Sugar Beet (Philadelphia) the following report of German experiments:

Sixty pounds of forage beets may be replaced by 10 pounds of dried cossette residuum, with a daily increase of 2 pounds in the milk production. (This is based on the weight of the cattle fed at 1,200 pounds.) On the other hand, for 92 pounds of forage beets was substituted 92 pounds of semifermented beet pulp. The daily milk increase was 3.8 pounds.

Here is another report from the same journal:

At the national convention held in Belgium it was pointed out that 150,000 acres cultivated in beets yielded 2,098,000 tons of beets, which were sold for $9,450,000. The value of the resulting pulp was $1,250,000 (13.45 per cent of price of beets), and was sufficient to feed 300,000 head of cattle.

The manager of a sugar factory who is not able to dispose of his pulp realizes that until he is able to do so his factory is sustaining considerable loss, so that factories of this kind are giving attention to pulp feeding to avert this loss. Some have been trying various devices for producing commercial dried pulp.

A PRACTICAL ILLUSTRATION.

The Standard Cattle Company at Ames, Nebr., after exhaustive experiments with pulp from the factories at Grand Island and Norfolk, at their extensive feeding concern at Ames, Nebr., concluded that its facilities would be very much enhanced if it had a sufficient supply of cheaper pulp than that shipped from such a distance. This led the company to promote the building of a sugar factory, those interested in the cattle company being largely the same as those in the sugar company. This sugar factory is medium in size, having a daily capacity of about 500 tons of beets, the object being to build a factory large enough to supply sufficient pulp for the use of the cattle company. Below I quote Mr. Allen, secretary of the cattle company, and one of the principal interested parties in the sugar company, with reference to the purposes in establishing a sugar factory, and as to general results in feeding the pulp:

It was my purpose in attempting to promote a factory at this point to secure pulp for feeding cattle and sheep for the benefit of the business of our cattle company. This was the initial idea of the whole project, and I confidently expect that our experience in the future will prove that the use of pulp will be of sufficient value to give us an advantage in feeding animals for the food supply as compared with our basis of business for the last fourteen years. In course of time I shall be able to give you our actual experience, which will be valuable. In the feeding of sheep the past winter, we feel very confident that we are on the right track and that our future feeding will be successful. I believe that the use of pulp will enable us to fatten cattle with less grain than it has been our practice to use, or, if we make the cattle eat an equal amount of grain, that they will be fattened within a shorter time. I prefer, however, to make a saving of grain and take a longer time for fattening the cattle, as the valuable results will be more certainly secured by taking plenty of time to do it.

I do not think it useful to attempt to give the value of pulp as compared with other food stuffs. This question is often asked in regard to oil cake, for instance, and it is not possible to answer it. At the present time it is the general belief that the principal value of pulp will be found in aiding digestion and maintaining sound health of animals. It has also unquestionably a food value. I do not make any attempt, however, to estimate the value of pulp in units as compared with units of some other kind of food. I think no rule for the feeding of pulp is necessary. I do not think it is important whether a greater or less amount of it is fed in proportion to rough forage and grain fed with it. My idea would be, when on a full feed, to

give less than a full grain ration in order to be certain of securing some economy in the use of pulp. I should, therefore, feed cattle, for instance, anywhere from 40 to 60 pounds of pulp and let them have all the rough forage they wish.

FEEDS AND FEEDING.

In the foregoing discussion of feeding sugar-beet pulp it has been my aim to present the subject briefly and clearly to the farmers of the country. Wherever possible I have avoided scientific and abstract statements. I think, however, in concluding this subject a plain primary statement of some of the scientific and practical laws of feeding, including nutrition and assimilation, will not be out of place. In this discussion I make no claim to originality. I simply present the results of the scientific investigations and practical experiences of others.

PRINCIPLES OF NUTRITION.

Every farmer knows from practical experience that animal life is closely associated with vegetable life; from a business standpoint he should be more or less versed in the economy of each. His domestic animals are almost entirely vegetarians. Vegetable life is therefore our first important consideration.

In studying processes and formulating nutritive materials for vegetable growth, we have to deal with the original elements. Vegetable life is the great chemical laboratory in which are compounded the organic matter on which animal life depends. It deals with the elements, while animal life deals with the compounds of elements. If we examine vegetables and animals analytically we will find quite similar compounds in vegetable and animal structure, the only difference being that in the growth of vegetables these compounds are manufactured, while in the growth of animals they are simply taken as found in vegetable foods and assimilated. As a great writer on this subject has said, "The vegetable elaborates and the animal appropriates."

There are four kinds of substances which the feeder must furnish the animal to promote growth and repair, or secure valuable products: (1) water; (2) different kinds of organic compounds in which nitrogen is the basic element; (3) different kinds of organic compounds in which carbon is the basic element; (4) different kinds of mineral compounds.

Out of these various substances found in the vegetable are made up the muscle, fat, bone, integuments, hair, hoof, milk, etc., of animals.

Water is a constituent element that enters into all parts of animal and vegetable tissues.

In its daily ration the animal must secure sufficient of that kind of food represented by nitrogen, the basic element found in several compounds of vegetable life, such as albumen, casein, and fibrin. This is the food that builds up the organs and tissues, the bone, and the milk product. These nitrogen compounds are known to the chemist as

proteids, and, collectively, are called protein. The proteids contain about 16 per cent of nitrogen.

Aside from protein food, we must supply in the daily ration of an animal substances in which carbon is the basic element, combined with hydrogen and oxygen, and producing the fat, heat, etc. These are known as the carbonaceous parts of the animal's food, and include the fats and carbohydrates. The fats include the oil of indian corn and other seeds and grains, and the carbohydrates include such bodies as starch, cellulose, dextrin, cane and grape sugar, and gums.

We must also include in an animal's ration mineral material for the building up and repairing of the bones and to some extent the organs and other tissues by adding phosphates and carbonates of lime, phosphate of magnesia, potash, and common salt.

Briefly, the first step in building up and repairing the body is through the consumption of food by the animal, having in view mainly three things—the muscle, the fat, and the bones or framework. After the food has been digested, the work is carried on by circulation of the blood to various parts. A chemical analysis of the blood would naturally reveal the presence of all the parts represented in the body, viz, about 79 per cent water, 20 per cent organic matter, and 1 per cent mineral matter. In weight the blood averages about 6 or 8 per cent that of the body.

Referring to the plant as the original source of all material for animal growth, we find that it derives its substance from two sources, the soil and the atmosphere; most of the nitrogen, the mineral matter, and the water coming from the soil, and the carbon from the atmosphere. From the soil the plant derives water (hydrogen and oxygen), ammonia (nitrogen and hydrogen), and the various compounds of minerals forming the incombustible part of the body, made up of sulphur, phosphorus, chlorin, potassium, calcium, magnesium, silicon, iron, and a few others. From the atmosphere the plant receives carbon and oxygen, the basic principles of the carbonaceous or carbohydrate and fatty elements of the plant that enter into the animal food from which the fats of the animal are formed and from which are derived the other carbonaceous compounds of the food needed in its physiological economy.

Below is given a table published by Mr. Stewart,[a] based on analyses, giving the chemical composition of the whole body of an animal as represented in two of its states, lean and fat:

Average composition of animal bodies.

Condition.	Water.	Dry fat.	Nitrogenous or flesh.	Mineral substances.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Lean	54	25½	17	3½
Fat	49	33	15	3

[a] Stewart, Feeding Animals, p. 25, 1890.

From the above we see that chemically an animal represents four kinds of substance: (1) water; (2) fat or organic matter from carbon; (3) flesh or organic matter rich in nitrogen; (4) inorganic substances.

OBJECTS OF FEEDING.

Turning now from analyses to synthesis, we come to that part with which the farmer has to deal. He must make an intelligent study of the food ration. A proper ration is one that produces the results that he wishes to attain. Food rations may be classed according to the object in feeding, as follows:

(1) A ration for brood animals.

(2) A ration for the purpose of securing the most and the best milk. This is the concern of the dairyman.

(3) A ration that produces the best quality and greatest weight of carcass. This concerns the feeder for meat production.

(4) A ration for a working animal affording power and endurance. This is general, and applies especially to the feeding of draft animals, roadsters, and racing animals.

I desire to attract the attention of the farmers of this country to the great desirability of a careful study of feeding and the possibilities to be attained by the employment of proper food rations; and to place before them data carefully compiled by others, representing years of close, careful, and scientific investigation.

It must be borne in mind that my ultimate object in this discussion is to show the farmers of this country the benefits that may be secured by using sugar-beet pulp as a food for stock. This effort will be well repaid if it attracts the attention of a few farmers to the fact that here is a useful article of food, which, as the sugar industry develops, is bound to be enormous in quantity, but which is at present in many places absolutely going to waste. For some time to come this valuable food product can be secured far below its actual value measured by any scale of prices that yet obtains in this country. In many places factories would be glad to give it to the farmers to get it out of their way. This condition will exist until the farming communities appreciate its utility and create a competition among themselves establishing a commercial value which will gradually increase until such time as it shall be a staple commercial product.

In feeding stock a farmer may have in view several things, as follows:

1. In the life history of an animal there is a constant change of its tissues caused by continual breaking down and replacement with new material. This material is furnished by a daily supply of food. This fact must be kept in view whatever specific object the farmer may have in feeding the animal. Every move, every breath is at the expense of animal tissue. Destruction of tissue is the price the animal

pays for existence. These tissues must be constantly replaced. Some tissues are broken down faster and rebuilt more often than others. Akin to this process of restoring broken down tissues is that of building a young animal to mature size, having in view the even development of all its parts without emphasizing any one in particular.

It is the scientist's province to study the changes in animal tissues and to inform the farmer as to the correct proportions of the different compounds of food required in building up these tissues. This food must be furnished to the animal in the proportion with which these various tissues are torn down, or in accordance with the purposes of the farmer in building up the various parts. This is called a balanced food ration.

2. In case of feeding animals for the meat market, it is the purpose to fatten and build up a carcass of meat filling the requirements of commerce.

3. It may be the purpose of the farmer simply to keep an animal in good, healthful condition without attempting to produce meat or dairy products.

4. It may be the purpose to give the animal a strong, healthful constitution and muscular tissue for performing work, as is accomplished with draft animals and other beasts of burden.

5. It may be the purpose to feed for the milk product.

6. It may be the purpose to feed for the best results in breeding.

There are other things that a farmer might possibly have in mind, but these are sufficient for the present purpose. The feeder is yet untutored in his business if he do not have a clear idea of the kind of food that should be furnished an animal to accomplish whatever purpose he may have in view. As has been indicated in this article, if he is feeding for fat, then he should supply the animal food containing a large proportion of the carbonaceous elements; if he is feeding for muscle, then he should select foods having high percentages of protein; if he is feeding for milk, he should have both of these in view. With a definite knowledge of the constituent elements of plants, it is easy to control the results by selecting the proper plant food entering into the food ration. Some are excessively nitrogenous and some are excessively carbonaceous. Some plants are more evenly balanced in the proportion of elements required in the food of the animal.

To accomplish the first of the purposes of feeding enumerated above, that of obtaining a healthy condition or of rearing an animal from the young to maturity, it is evident that the ration should be one having a more narrow nutritive ratio than when fattening is the object; that is to say, there should be more of the protein and less of the carbohydrates and fats. Nature has furnished us a very valuable guide, especially in rearing and building up young animals. This is to be found in the constituent elements of milk, the natural food provided for rearing all

young. The farmer should examine into the composition of milk and compose his food ration somewhat after the pattern set by nature, especially after a young animal is taken off of milk. Below I give Mr. Stewart's table showing the composition of milk:

Composition of milk.

Constituents.	Cow's milk.	Mare's milk.	Ewe's milk.
	Per cent.	*Per cent.*	*Per cent.*
Casein, or flesh formers	4.05	3.40	4.50
Butter } food of respiration and fat	3.80	2.50	4.20
Milk sugar } food of respiration and fat	4.55	3.52	5.00
Salts or ash	.60	.53	.68
Water	87.00	90.05	85.62
	100.00	100.00	100.00

The second in the list of purposes mentioned is that of fattening. Nearly all ordinary grain foods are rich in fat and carbonaceous matter (see table, page 22). These are specially useful in the production of animal heat, but in their natural state they are not found to form part of the animal tissues. They may be classed as the fuel supplying the forces of animal life:

COMPOSITION AND NUTRITIVE RATIOS OF FEEDS.

It is not my intention to follow out the various purposes a farmer may have in view in feeding an animal. I have aimed to say enough to suggest the importance of every farmer giving careful attention to the food ration in order to accomplish the different purposes he may have in mind. We often hear the term nutritive ratio mentioned in connection with a particular ration or a single article of food. The nutritive ratio is simply the ratio between the nitrogenous and the carbonaceous elements found in the ration or the food. The ratio does not indicate the richness of the food in nutrient elements, simply the proportion of the elements of the two classes. The ratio expresses the value of the food measured by the purpose. If the farmer is fattening stock, he wants a wide nutritive ratio, and, therefore, leans strongly toward the carbonaceous. If he has in view a muscular development of the animal, he leans toward the nitrogenous in his food ration. In finding the nutritive ratio of any particular food we divide the amount of digestible carbonaceous matter in the plant, which is made up of the carbohydrates plus 2.25 times the fat, by the amount of the digestible nitrogenous matter. The farmer can supply the quantity when he once knows the quality. Different kinds of food vary greatly as to the amount of water contained. In the cereals the water content runs from 13 to 20 per cent; in root crops from 75 to 90 per cent. Two foods may be equally valuable so far as

the nutritive ratio is concerned, but very divergent in their commercial value on account of the difference in the amount of water and waste. In regard to milk Mr. Stewart says:

If we take the analysis of cow's milk, as an example (milk being in solution, it is all digestible), fat is 3.80 per cent. This multiplied by 2.4 gives 9.12 per cent; and this added to the milk sugar, 4.55 per cent, makes 13.67 per cent as the carbohydrates of milk. If this be divided by the casein or albuminoids, 4.05 per cent, the result is 3.37, the nutritive ratio of milk (1:3.37) that is, milk has 1 part of albuminoids to 3.37 of carbohydrates.

It is not my purpose to go further into the discussion of the nutritive ratios or constituent elements of feeds in general. But I want to suggest to feeders careful examination of the data furnished in the following table of constituent elements indicating nutritive ratios of the common grains and other feeding stuffs entering into a food ration as furnished by Dr. E. W. Allen, Assistant Director of the Office of Experiment Stations in Farmers' Bulletin No. 22, on the Feeding of Farm Animals.

Dry matter and digestible nutrients in 100 pounds of feeding stuffs.

Feeding stuff.	Total dry matter.	Protein.	Carbohydrates.	Fat.	Fuel value.
Green fodder:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Corn fodder[a] (average of all varieties)	20.7	1.10	12.08	0.37	26,076
Kafir-corn fodder	27.0	0.87	13.80	0.43	29,101
Rye fodder	23.4	2.05	14.11	0.44	31,914
Oat fodder	37.8	2.44	17.99	0.97	42,098
Redtop, in bloom	34.7	2.06	21.24	0.58	45,785
Orchard grass, in bloom	27.0	1.91	15.91	0.58	35,593
Meadow fescue, in bloom	30.1	1.49	16.78	0.42	35,756
Timothy,[b] at different stages	38.4	2.01	21.22	0.64	45,909
Kentucky blue grass	34.9	2.66	17.78	0.69	40,930
Hungarian grass	28.9	1.92	15.63	0.36	34,162
Red clover, at different stages	29.2	3.07	14.82	0.69	36,187
Crimson clover	19.3	2.16	9.31	0.44	23,191
Alfalfa, at different stages	28.2	3.89	11.20	0.41	29,798
Cowpea	16.4	1.68	8.08	0.25	19,209
Soy bean	28.5	2.79	11.82	0.63	29,833
Rape	14.3	2.16	8.65	0.32	21,457
Corn silage (recent analyses)	25.6	1.21	14.56	0.88	33,046
Corn fodder, a field cured	57.8	2.34	32.34	1.15	69,358
Corn stover, field cured	59.5	1.98	33.16	0.57	67,766
Kafir-corn stover, field cured	80.8	1.82	41.42	0.98	84,562
Hay from—					
Barley	89.4	5.11	35.94	1.55	82,894
Oats	84.0	4.07	33.35	1.67	76,649
Orchard grass	90.1	4.78	41.99	1.40	92,900
Redtop	91.1	4.82	46.83	0.95	100,078
Timothy[b] (all analyses)	86.8	2.89	43.72	1.43	92,729
Kentucky blue grass	78.8	4.76	37.46	1.99	86,927
Hungarian grass	92.3	4.50	51.62	1.34	110,181
Meadow fescue	80.0	4.20	43.34	1.73	95,725
Mixed grasses	87.1	4.22	43.26	1.33	93,925
Rowen (mixed)	83.4	7.19	41.20	1.43	96,040
Mixed grasses and clover	87.1	6.16	42.71	1.46	97,059
Red clover	84.7	7.38	38.15	1.81	92,324
Alsike clover	90.3	8.15	41.70	1.36	98,460
White clover	90.3	11.46	41.82	1.48	105,346
Crimson clover	91.4	10.49	38.13	1.29	95,877
Alfalfa	91.6	10.58	37.33	1.38	94,936
Cowpea	89.3	10.79	38.40	1.51	97,865
Soy bean	88.7	10.78	38.72	1.54	98,569
Wheat straw	90.4	0.37	36.30	0.40	69,894
Rye straw	92.9	0.63	40.58	0.38	78,254
Oat straw	90.8	1.20	38.64	0.76	77,310
Soy-bean straw	89.9	2.30	39.98	1.03	82,967

[a] Corn fodder is entire plant, usually sown thick.
[b] Herd's grass of New England and New York.

Dry matter and digestible nutrients in 100 pounds of feeding stuffs—Continued.

Feeding stuff.	Total dry matter.	Protein.	Carbohydrates.	Fat.	Fuel value.
Roots and tubers:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Potatoes	21.1	1.36	16.43	.....	33,089
Beets	13.0	1.21	8.84	0.05	18,904
Mangel-wurzels	9.1	1.03	5.65	0.11	12,889
Turnips	9.5	0.81	6.46	0.11	13,986
Ruta-bagas	11.4	0.88	7.74	0.11	16,497
Carrots	11.4	0.81	7.83	0.22	16,999
Grains and other seeds:					
Corn (average of dent and flint)	89.1	7.14	66.12	4.97	157,237
Kafir corn	87.5	5.78	53.58	1.33	116,022
Barley	89.1	8.69	64.83	1.60	143,499
Oats	89.0	9.25	48.34	4.18	124,757
Rye	88.4	9.12	69.73	1.36	152,400
Wheat (all varieties)	89.5	10.23	69.21	1.68	154,848
Cotton seed (whole)	89.7	11.08	33.13	18.44	160,047
Mill products:					
Corn meal	85.0	6.26	65.26	3.50	147,797
Corn-and-cob meal	84.9	4.76	60.06	2.94	132,972
Oatmeal	92.1	11.53	52.06	5.93	143,302
Barley meal	88.1	7.36	62.88	1.96	138,918
Ground corn and oats, equal parts	88.1	7.01	61.20	3.87	143,202
Pea meal	89.5	16.77	51.78	0.65	130,246
Waste products:					
Gluten meal—					
Buffalo	91.8	21.56	43.02	11.87	170,210
Chicago	90.5	33.09	39.96	4.75	155,918
Hammond	91.9	24.90	45.72	10.16	174,228
King	92.8	30.10	35.10	15.67	187,399
Cream gluten (recent analyses)	90.4	30.45	45.36	2.47	151,420
Gluten feed (recent analyses)	91.9	19.95	54.22	5.35	160,533
Buffalo (recent analyses)	91.0	22.88	51.71	2.89	150,933
Rockford (Diamond)	91.3	20.38	54.71	3.82	155,788
Hominy chops	88.9	8.43	61.01	7.06	158,952
Malt sprouts	89.8	18.72	43.50	1.16	120,624

COMPOSITION OF SUGAR BEETS AND PULP.

The following figures, published in a recent issue of the Beet-Sugar Gazette (Chicago), will show the constituent elements of fresh, pressed, and dried pulp:

Composition of sugar-beet pulp.

	Fresh pulp.	Pressed pulp.	Dried pulp.
	Per cent.	*Per cent.*	*Per cent.*
Water	94.0	89.8	5.0
Ash	0.4	0.6	5.59
Crude protein	0.5	0.9	8.39
Crude fiber	1.4	2.4	22.35
Nonnitrogenous extractive matter	3.6	6.1	56.81
Crude fat	0.1	0.2	1.86
DIGESTIBLE MATTER.			
Albumen	0.3	0.6	.....
Nonnitrogenous extractive matter	3.0	5.1	.....
Crude fiber	1.2	2.0	.....
Fat	0.1	0.2	.....
Nutritive ratio	7.65	7.28	7.25

In order to compare the constituent elements and nutritive ratio of beet pulp with those of other common feeds, I will introduce the report of Dr. Wiley, Chief of the Bureau of Chemistry, Department of

Agriculture, on a sample of pulp that was sent by Mr. N. H. Stewart, one of the principals in the beet-sugar factory at Kalamazoo, Mich.:

JANUARY 21, 1903.

The SECRETARY OF AGRICULTURE.

SIR: In reply to your request for some information in regard to the relative feeding value of sugar beets and exhausted pulps, I beg to state that I have made the following investigation:

In addition to the analysis of the samples which were sent in the tin can from Mr. N. H. Stewart, of Kalamazoo, Mich., I made a comparative analysis of some beets which had been sent to the laboratory, and afterwards extracted the beets to the average extent to which they are treated in a diffusion battery, and thus secured a pulp from the same lot of beets at first analyzed. By making an examination in this way a direct comparison is secured between the beets and the pulps produced therefrom. The analytical data obtained are as follows:

Results of analyses of sugar beets and sugar-beet pulp.

Constituent.	In the beet.	In the pulp.	In the pulp from Michigan.
	Per cent.	*Per cent.*	*Per cent.*
Water	74.70	93.05	91.25
Ash	1.16	0.24	0.30
Fat	0.02	0.06	0.21
Crude fiber	1.38	1.30	1.59
Sucrose	15.80	0.35	0.00
Protein	0.43	0.66	0.84
Amids	0.85	0.03	0.05
Organic acids, soluble cellulose, and undetermined	5.66	4.31	5.76

The beets were prepared by removing all of the leaf stalks, but the necks were not cut away as is usually the case in the manufacture of sugar. In the study of the analysis of the beets and the pulps made therefrom this must be borne in mind. * * *

In order to compare the value directly, it is necessary to convert all of the data to dry substance. Converting the data to dry substance, we have the following table:

Composition of dry matter in sugar beets and sugar-beet pulp.

Constituent.	In the beet.	In the pulp.	In the pulp from Michigan.
	Per cent.	*Per cent.*	*Per cent.*
Ash	4.59	3.45	3.43
Fat	0.08	0.86	2.40
Crude fiber	5.45	18.71	18.17
Sucrose	62.45	5.04	0.00
Protein	1.70	9.50	9.60
Amids	3.36	0.43	0.57
Organic acids, soluble cellulose, and undetermined	22.37	62.01	65.83

In computing the nutritive value of the above, the quantities of soluble cellulose and crude fiber available must be determined by the ordinary results of digestion with these bodies.

It may be assumed from all of the data presented that 88 per cent of these bodies may be reckoned among the digestible carbohydrates. This would give the total digestible carbohydrate percentage for the beet, which is the sum of the sucrose and 88 per cent of the crude fiber, the organic acids, soluble cellulose, and undetermined, at 86.93 per cent. The fat multiplied by 2.25 added to this gives a total digestible carbohydrate and fat percentage of 87.11. The protein is 1.70 only, giving a ratio of 1 to 51.2.

In the pulp extracted from the beets the sugar, which consists of considerably more than half of the substance, was nearly all taken away. The relative proportions of fiber and cellulose are of course increased, the sum of the fiber and cellulose being 80.72 per cent. Assuming a digestibility of 88 per cent, we have a total percentage of these digestible carbohydrates of 71.03. Add to this the sucrose and 2.25 times the fat, viz, 1.94, and we have 78.01 as the percentage of total digestible carbohydrates and fat. Assuming, as in the case of the beets, that the protein is practically all digestible, we have the ratio of 1 to 8.21.

In the pulp from Michigan the sucrose had all fermented, except a mere trace, not sufficient to determine by chemical or optical methods. The sum of the percentage of crude fiber, soluble cellulose, etc., is 84 per cent. Assuming that it has a digestibility of 88 per cent, we have a total of digestible carbohydrates of 73.92 per cent. Add 2.25 times the percentage of fat, viz, 5.4 per cent, and we have a total of 79.32 per cent of digestible fat and carbohydrates. Assuming, again, that the protein is all digestible, we have a nutritive ratio of 1 to 8.26.

It will be noticed that in the above analysis the protein has been assumed to be all digestible. This is a fair assumption, because the indigestible nitrogenous bodies, viz, the amids, were separately determined and no account was taken of them in the nutritive ratio. As the amids are, as a rule, soluble in water, it is not strange that there is a very much larger percentage of them in the beets than in the pulp.

When figured on the dry substance, it is seen that the beets themselves form a food in which the nutritive ratio is excessively wide—that is, a food in which there is an immense excess of carbohydrates. On the other hand, the pulps produce a food in which the nutritive ratio is reasonably narrow. This difference arises from the fact that the carbohydrates in the beets are mostly soluble, while the protein is mostly insoluble, only the amid nitrogen bodies passing into solution. Thus, in the case of the extraction of the sugar in the diffusion battery, the percentage of carbohydrates in the dry substance is diminished, while the percentage of protein in the pulps is increased.

In regard to the quantities of water in the pulps, as determined by the ordinary method of drying, they are found to be 93.05 and 91.25, respectively. Since, however, some of the water in the pulp is doubtless in a state of hydration with the cellulose, a portion of it may still be found in the undetermined substance. For practical purposes, however, the data obtained in the analysis are entirely reliable.

I think the above data will give complete answers to your inquiries in regard to the beets and the pulps made therefrom for feeding purposes, and, in so far as I know, this is the only analysis on record in which the pulps represent directly the beets with which they are brought into comparison.

Very respectfully, H. W. WILEY, *Chief.*

Dr. Wiley's analysis of the pulp furnished by Mr. Stewart shows that the nutritive ratio is 8.26 and the nutritive ratio of the pulp produced from the beets in Dr. Wiley's work is 8.21. Stewart gives the nutritive ratio of Indian corn as 8.6, which is very nearly the same as that of pulp.[a]

The manager of the Alma Sugar Company, Mr. Hathaway, sent to the Department of Agriculture a specimen of dried pulp. The production of dried pulp in this country is a new industry. Up to date we have made very little progress in the production of dried pulp or in creating a demand for it after it has been prepared. Since dried pulp will very naturally play an important part in the beet-sugar

[a] Stewart, Feeding Animals, p. 140, 1890.

industry of this country in the future, the analysis of this sample is interesting at this time. The drying process at Alma gives evidence of success. In the process of drying, the waste molasses of the sugar factory is mixed with the pulp, and for this reason the nutritive ratio, 9.05, is a little wider than is that of plain pulp, either pressed or dried. Dr. Wiley shows that this pulp contains about 18 per cent sugar, while ordinary pulps show but a slight amount of sugar. This difference is due to the use of the waste molasses.

While this pulp product shows up strong as a whole, I am inclined to doubt the expediency or helpfulness of adding the molasses. It may promote fattening, and probably, as this waste molasses is of very little value to sugar factories up to date in this country, this may be the best means of disposing of it at present.

I give below Dr. Wiley's report on the dried pulp produced by the factory at Alma, Mich.:

JANUARY 28, 1903.

The SECRETARY OF AGRICULTURE.

SIR: The cattle food, composed of desiccated beet pulp mixed with molasses, and sent on by the Alma Sugar Company, of Alma, Mich., has been entered under No. 919 I. and W. The analytical data obtained on this sample are as follows:

	Per cent.
Moisture	4.01
Fat	.48
Crude fiber	14.25
Ash	4.97
Pentosans	20.94
Albuminoids	6.56
Amids	2.21
Sugars	17.99
Soluble cellulose, gums, starch, organic acids, and undetermined	28.59

The sample, when treated with water, was found to give 74.99 per cent of insoluble matter and 25.01 per cent of soluble matter. The soluble matter had the following composition:

	Per cent.
Cane sugar	14.16
Invert sugar	3.83
Salts and gums	3.01
Moisture	4.01

The above data show that this material is very dry, containing only 4 per cent of moisture, indicating that the process of desiccation has been very perfectly performed. When placed in hot water this material swells up very rapidly and assumes practically the bulk originally occupied by it when coming from the diffusion batteries. The analysis shows that about 25 per cent of the dry material comes from the molasses which has been used. It is seen from the data that the molasses has the composition of ordinary beet molasses which has been subjected to high temperatures, inverting a portion of the sugar. The indigestible portions of the material are represented by the crude fiber, pentosans, ash, and amids. I would say, however, in this respect, that a considerable portion of the crude fiber and the pentosans is digestible.

In regard to the amid nitrogen, it is well known that it is not anything like as valuable as protein or albuminoid nitrogen for food purposes. While it may have

some value in the system, it is not very great, and therefore I have reckoned it among the indigestible portions.

The soluble cellulose, the fat, the albuminoids, and the sugars are all digestible. Of course, only digestion experiments could determine accurately the proportionate digestibility of the sample, but it is safe to say, from the analytical data, that in round numbers two-thirds of this material is digestible and assimilable, and probably more.

As has been stated, it is not possible from a mere chemical analysis to indicate accurately the ratio between the digestible protein and the digestible carbohydrates and fat. A very good approximation, however, can be made of this ratio by a careful study of the analytical data. For this purpose the digestible carbohydrates in the foregoing sample may be taken as follows:

All of the soluble cellulose, gums, starch, etc., viz, 28.59 per cent; all of the sugar, viz, 17.99 per cent; one-third of the crude fiber and pentosans, viz, 11.73 per cent, and 2.25 times the fat, viz, 1.08 per cent, making a total of digestible carbohydrates and fat of 59.39 per cent.

While it is true that probably all of the albuminoids are not digestible, yet a sufficient amount of the amids would be digested to represent any deficit, so that the full number for albuminoids may be taken, viz, 6.56 per cent. The ratio then is $59.39 \div 6.56 = 9.05$.

It must not be inferred that the indigestible portions of the food are of no value. They serve to distend the digestive organs and to make possible the peristaltic action of the intestines necessary to the processes of digestion and assimilation.

Respectfully,

H. W. WILEY, *Chief.*

DETERMINATIONS OF NUTRITIVE RATIO AND VALUE OF PULP IN EUROPE.

In this connection I wish to introduce some extracts taken from the Yearbook of the Department of Agriculture for 1898, prepared by Guilford L. Spencer, assistant in the Division of Chemistry, on Utilization of Residuum from Beet-sugar Manufacturing in Cattle Feeding. The matter here used was prepared by him from observations made in the beet-sugar districts of Europe:

The following may be considered an average analysis of diffusion pulps:

Analysis of diffusion pulps.

Constituent.	Fresh pulp.	Dry material.
	Per cent.	*Per cent.*
Moisture	89.09	.....
Nitrogenous matter	0.92	8.43
Digestible carbohydrates	6.52	59.76
Indigestible carbohydrates	1.98	18.15
Fat	0.09	0.83
Mineral matter	1.40	12.83
Total	100.00	100.00
Solid matters	10.91	.....

The analyses, of which the above table gives mean results, were made by a commission of experts in France, including Messrs. Dupont, Vivien, Lucas, Duvin, and Durot. A brief résumé of feeding experiments conducted by this commission will be given further on.

A small percentage of cane sugar is included in the percentage of digestible carbohydrates given in the table. After the pulp has been stored in silos for a short time,

the sugar, which does not usually exceed from 4 to 6 pounds in quantity in a ton of the fresh material, gradually disappears through fermentation, and therefore is lost, at least in part, before the pulp is fed. The nutritive ratio (per cent fat multiplied by 2.25 plus per cent digestible carbohydrates, divided by per cent proteids) of diffusion pulps approximates 1:7.2. This is a medium ratio, and agrees fairly well with the Wolff-Lehmann standard for fattening a steer. A calculation on a somewhat different basis, assigning a money value to each of the constituents of the materials, indicates that beet pulp is worth about half as much as corn silage.

The usual European practice in feeding beet pulp to beef cattle is to mix a small quantity of linseed-oil cake and chopped alfalfa with the material.

The above table shows the nutritive ratio of pressed pulp to be 7.2.

In the development of the beet-sugar industry in Germany there have been several processes in general use for extracting the sugar from the beets. The pulp resulting from these different processes has differed in value for feeding purposes. It is probable that the feeding value of pulp is highest under the diffusion process now in vogue in Germany, and the world over for that matter. The change to diffusion processes brought on litigation in Germany, and, before the courts could settle the question accurately, it became necessary to carry on extensive and scientific feeding experiments to determine the value of diffusion pulp. In regard to the result of these experiments I quote again from Dr. Spencer's article:

The following animals were used in the tests: (1) Beef cattle; (2) oxen; (3) milch cows; (4) sheep; (5) ewes. Before beginning the tests the animals were all gradually accustomed to the change from their customary ration to diffusion pulp.

(1) *Beef cattle.*—Twelve beeves each received every day, in three meals, 115 pounds of diffusion pulp, mixed with 6.6 pounds chopped alfalfa and 6.6 pounds linseed-oil cake. Their weight increased an average of 2.214 pounds per day. Taking into account the values of the increased weight of meat, and of the alfalfa and linseed-oil cake, that of the diffusion pulp is $1.316 per 1,000 kilograms (2,200 pounds).

(2) *Oxen.*—Four oxen received each per day 126.8 pounds of diffusion pulp, mixed with 12 pounds of alfalfa and 2.2 pounds of linseed-oil cake. These cattle decreased in weight somewhat the first fifteen days and did less work than usual, but in the second fifteen days they had entirely recovered. The trial continued two months and a half. In making a calculation similar to the one above, the value of the diffusion pulp was $0.956 per 1,000 kilograms (2,200 pounds).

(3) *Milch cows.*—The test with cows lasted thirty days. Two cows were used, one Flemish, the other Dutch. Prior to the test the cattle were fed on dry alfalfa with a small quantity of press pulps from beets. The cows were each given per day 99.2 pounds of diffusion pulp with 4.4 pounds of alfalfa. The tests indicated that the pulp is of greater value as regards lactation than in the production of flesh. * * * The butter produced from this milk did not have the peculiar odor which is present in that from cows fed on press pulps.

(4) *Sheep.*—In this test 20 Merino sheep were fed on diffusion pulp. The rations fed per animal and the resulting increase were as follows:

Average rations per head:	Pounds.
Pulp	11.88
Linseed-oil cake	0.44
Chopped alfalfa	1.10
Weight of sheep:	
April 4	2,085.6
April 26	2,217.6
Total increase	132.0

The sheep eat the pulp with avidity; hence it is unnecessary to make other additions to it. On a basis of this experiment with sheep, the value of the diffusion pulp was calculated to be $1.74 per 1,000 kilograms (2,200 pounds).

(5) *Ewes.*—The ewes were obtained from a flock from which the lambs had just been separated. In feeding the ewes, to which a somewhat larger ration was given than in the preceding experiment, the value of the pulp was calculated to be $1.206 per 1,000 kilograms (2,200 pounds).

Not taking into account transportation, the commission estimated the value of the pulp per 1,000 kilograms (2,200 pounds) at $1.22, and from calculations based on a cattle food analysis, at $1.288.

From these experiments one may draw the same conclusion relative to the feeding value of pulp as was drawn from the analytical data, namely, the material is very fattening food. The experiments in question, and many others also, indicate that pulp may be fed to dairy cattle with great success. The results with cattle doing heavy work indicate that pulp will find its best application in fattening animals for the market and in feeding milch cows rather than as a ration for draft animals.

With a proper set of analytical tables showing the composition of different food plants, their content of digestible nutrients, and their nutritive ratios, the farmer who applies himself to the study of the subject and exercises good judgment can learn to feed his animals intelligently and profitably. Every farmer should have such tables and should apply himself diligently to working out suitable rations for his animals from such foods as are available. Correspondence with the scientists of his State experiment station on this subject will be time well spent, and will yield better returns than the same effort directed in any other way. Every intelligent farmer can make up his own feeding rations. It is too often the case that farmers are actually working in the dark on this subject. In many cases they have simply inherited the ideas and practices of their fathers, and have never given the subject of feeding any intelligent consideration.

In agriculture we are leaving the old, unsettled "hit-and-miss" methods, and along with the rest of the world are forced to apply the principles of economy and science.

Fortunate indeed is the farmer who is situated where he can secure sugar-beet pulp. For fattening we have been too much inclined to condensed rations, largely made up of cereals, hay, and water, too dry and too compact, requiring too much of the digestive organs. Sugar-beet pulp enters readily into any balanced food ration designed for specific purposes. No single item makes a food ration. This statement is as true of corn as it is of pulp, and vice versa. I would not undertake to discourage the use of cereals in the proper place in a food ration. I do wish to encourage the introduction of other foods along with them, especially succulent foods, a good type of which we find in sugar-beet pulp. It is available in large quantities, it is nutritious, and its sanitary effect is remarkable. Its aid to digestion is its strongest recommendation.

I wish now to call attention to the food rations for different purposes established in Germany after many years of scientific experiment and

RATIONS FOR CATTLE AND SHEEP CONTAINING SUGAR-BEET PULP.

actual experience. I would ask the farmer to examine these carefully, substituting whatever he may have for those things in the German ration which are not available.

From my last report I quote information furnished by United States Consul Baehr at Magdeburg, Germany, on the rations for cattle and sheep in which sugar-beet pulp enters. These are rations that the German people have worked out according to their experience as to how much sugar-beet pulp should be included along with other foods in a ration. Different kinds of rations are offered, made up of different kinds of feed, each including sugar-beet pulp.

Probably in no other country in the world has the feeding of beet pulp been studied and tested more extensively or scientifically than in Germany. This report is very interesting as giving the conclusions reached after years of experience.

In the headlines introducing each of the various food rations the consul gives the number of pounds of "dry matter" entering into the ration. This refers to the ration free from moisture. In the ration itself the weight given to each item refers to the food with its natural moisture. The consul gave in these rations the weights according to the metric system. I have given the equivalents in pounds avoirdupois.

In giving the "live weight" upon which each ration is based, the reader must not confound this unit of weight with the weight of a single animal. Several animals may be required to make up this unit of live weight. The rations as reported by the consul are as follows:

There is no difference between the results of feeding fresh pulp and that which has been stored in a silo. Both kinds have the same effect and are therefore used in equal quantities. The difference between them is that according to the manner of storing from 15 to 30 per cent of the substance is lost by decay in the silos. In the following tables moist pulp is referred to:

I. Draft oxen with fair amount of work.

Food requirements per 2,200 pounds live weight, per day—

	Pounds.
Dry substance, about	55.0
Containing—	
Protein	4.4
Fat	0.1
Carbohydrates	25.3
Ration recommended:	
Fresh pulp	132.0
Meadow hay	13.2
Summer straw	11.0
Winter straw	11.0
Malt sprouts	4.4
Cotton-seed cake	5.5

Ration for same with less work:

	Pounds.
Fresh pulp	88.0
Winter straw	17.6
Pulse chaff	26.4
Cotton-seed cake	3.3

II. Dairy cows.

Food requirements per 2,200 live weight, per day—

	Pounds.
Dry substance, about	59.4
Containing—	
Protein	4.4
Fat	8.8
Carbohydrates	24.2
Rations recommended to produce 16.5 pounds milk daily:	
No. 1—	
Fresh pulp	66.0
Clover hay	11.0
Meadow hay	11.0
Oat straw	11.0
Wheat chaff	6.6
Malt sprouts	4.4
Oat bran	2.2
Palm-seed flour	4.4
Rice-seed flour	3.3
Meal	1.1
No. 2—	
Fresh pulp	88.0
Afalfa hay	11.0
Clover hay	6.6
Meadow hay	8.8
Winter straw	17.6
Rye bran	2.2
Coarse wheat bran	4.4
Cotton-seed cake	1.1
No. 3—	
Fresh pulp	110.0
Clover hay	13.2
Meadow hay	11.0
Summer straw	8.8
Linseed cake	4.4
Sesame flour	3.3
Winter straw	6.6

Rations recommended to produce 22 pounds of milk daily per 2,200 pounds live weight, per day—

	Pounds.
Dry matter, about	63.8
Containing—	
Protein	5.5
Fat	1.1
Carbohydrates	31.6
No. 1—	
Fresh pulp	77.0
Meadow hay	8.8
Clover hay	13.2

Rations recommended to produce 22 pounds of milk daily per 2,200 pounds live weight, per day—Continued.

No. 1—Continued.	Pounds.
Oat straw	8.8
Wheat chaff	6.6
Moist beer grains	44.0
Malt sprouts	4.4
Rape-seed cake	5.5
No. 2—	
Fresh pulp	99.0
Clover hay	19.8
Summer straw	13.2
Winter straw	6.6
Wheat chaff	4.4
Peanut cake	5.5
Palm-seed cake	11.0

III. Fattening cattle.

Food requirements per 2,200 pounds live weight per day—

	Pounds.
Dry matter	66.0
Containing—	
Protein	6.6
Fat	1.5
Carbohydrates	31.9
Rations recommended:	
Fresh pulp	110.0
Clover hay	13.2
Alfalfa hay	13.2
Barley straw	13.2
Moist beer grains	44.0
Bruised corn	6.6
Peanut cake	2.2

IV. Fattening sheep.

Food requirements per 2,200 pounds live weight, per day—

	Pounds.
Dry matter, about	61.6
Containing—	
Protein	7.7
Fat	1.3
Carbohydrates	31.9
Rations recommended:	
Fresh pulp	110.0
Alfalfa hay	26.4
Straw	17.6
Rye flour	12.1
Rape-seed cake	8.8

V. Growing cattle.

Six to 8 months old, weighing about 550 pounds, daily fodder, per head—

	Pounds.
Dry substance, about	13.86
Containing—	
Protein	1.39
Fat	4.40
Carbohydrates	7.48

Rations recommended:	Pounds.
Fresh pulp	22.0
Meadow hay	8.8
Summer straw	4.4
Oats	2.2
Sesame cake	1.1
Linseed	.29

Age about 12 to 18 months, weight about 748 pounds, daily rations, per head—

	Pounds.
Dry substance, about	18.04
Containing—	
Protein	1.54
Fat	.44
Carbohydrates	9.24
Rations recommended:	
Fresh pulp	22.0
Meadow hay	8.8
Summer straw	6.6
Oats	2.2
Malt sprouts	1.1
Palm-seed cake	1.1
Sesame cake	.5

VI. Growing sheep: Age, 8 to 11 months; weight, 101.2 pounds.

Food requirements per 100 sheep, per day—

	Pounds.
Dry substance, about	244.2
Containing—	
Protein	30.8
Fat	5.5
Carbohydrates	145.2
Rations recommended:	
Fresh pulp	200
Meadow hay	110
Pulse chaff	44
Oat chaff	22
Linseed	33
Rape-seed cake	33
Rye flour	22
Wheat flour	22

COMMERCIAL VALUE OF PULP.

The farmer is naturally of a practical turn of mind. When anything new is recommended he naturally asks what is its determined monetary value. All through this article on pulp feeding I have aimed to show that there are values to fresh pressed pulp that are undetermined. But I fully understand that the money value is the easiest understood. I will briefly summarize what I have shown with reference to the actual money value of pulp.

I. The Colorado experiment station concluded after exhaustive experiments that for certain purposes pulp costing $1.50 per ton could be fed at a profit.

II. The Michigan experiment station decided that a ton of pulp produced 41 pounds, live weight, of beef. This at 5 cents, ordinary price, gave the pulp, without profit, a feeding value of $2.05 per ton.

III. The New York experiment station decided that in feeding value a ton of pulp was equal to one-half a ton of silage.

IV. The courts of Germany in connection with litigation instituted extensive scientific and practical experiments in feeding, and arrived at the following conclusions:

(*a*) For beef cattle pulp is worth $1.32 per metric ton (2,200 pounds).

(*b*) For work oxen it is worth 97 cents per ton.

(*c*) For milch cows it is of much more value than for any other purpose.

(*d*) For sheep it is worth $1.74 per ton.

The commission determined that, not taking into account the transportation, the estimated value of pulp for 2,200 pounds to be $1.22, and it calculated the value by comparisons with other foods analyzed to be $1.29.

FOOD AS SOURCE OF FERTILITY TO SOIL.

As land becomes more valuable through density of population and its original fertility becomes exhausted, we are forced more and more to resort to fertilizers. In the older countries, like Germany, France, and England, where agricultural lands are worth $500 to $800 an acre, it becomes necessary for the farmers to produce the most possible at the smallest cost. This has led them to an exhaustive study of the application of fertilizers. We are moving in the same direction, and in the end we will have to give the subject as close attention as the people of any other country. The English feeder or farmer studies carefully the amount of fertilizer that will return to him again in the excretions of the animal when it is fed. He appreciates that there is no loss of matter, that it still exists somewhere in some state. When nitrogen, phosphorus, and potash are fed in an animal ration, he knows that whatever the animal assimilates makes up its muscles, brain, bones, etc. Whatever is not used by the animal is returned to him again in excretions, which he carefully husbands and restores to the soil. The only way he is deprived of any portion of fertility originally existing in the foods is by selling the carcass of the animal off the farm or by selling animal products, such as milk.

The following table, compiled by Dr. E. W. Allen, of the Office of Experiment Stations, shows the amount of nitrogen, phosphorus, and potash found in a number of ordinary plant foods entering into the ration of animals, the total value of these fertilizers per ton of feed.

Ash contituents and nitrogen of farm plants and products.

[Amounts and value per ton.]

Substance.	Water.	Nitrogen.	Potash.	Phosphoric acid.	Estimated fertilizing value per ton [a]
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	
Hay of mixed grasses	239.8	28.2	31.0	5.4	$5.85
Timothy hay	150.4	25.2	18.0	10.6	4.98
Alfalfa hay	131.0	43.8	33.6	10.2	8.44
Red clover hay	226.6	41.4	44.0	7.6	6.53
Sugar beets	1,739.0	4.4	9.6	2.0	1.20
Mangel-wurzels	1,745.8	3.8	7.6	1.8	1.00
Turnips	1,789.8	3.6	7.8	2.0	.99
Carrots	1,795.8	3.0	10.2	1.8	1.02
Corn kernels	217.6	36.4	8.0	14.0	6.24
Barley [b]	286.0	34.2	9.6	15.8	5.49
Oats	363.4	41.2	12.4	16.4	7.25
Wheat (spring)	287.0	47.2	7.8	14.0	7.79
Wheat (winter)	295.0	47.2	12.2	17.8	8.17
Rye	298.0	35.2	10.8	16.4	6.30
Gluten meal	171.8	100.6	1.0	6.6	14.90
Cotton-seed meal	156.2	135.8	17.4	57.6	22.86
Linseed meal (new process)	155.4	115.6	27.8	36.6	19.62
Skim milk	1,805.0	11.2	3.8	4.0	1.97
Wheat bran	234.8	58.4	32.2	57.8	11.66
Wheat straw	251.2	11.8	10.2	2.4	2.32
Sugar-beet pulp and molasses cake [c]	1,400.0	5.8	7.6	2.2	1.31

[a] Fertilizing value per ton estimated by assuming nitrogen to be worth 14½ cents per pound, potash 5 cents, phosphoric acid 4 cents.
[b] Dietrich and König.
[c] Landwirtschaftlicher Kalender.

It would be impossible to give in general tables the amount of fertilizer returned in the manure, since it varies with the maturity, activity, and use of the animal. A young animal or a milk producer would return less than a mature or a work animal. The part returned may vary from 50 to 90 per cent. It may be roughly estimated that with the animals on the average farm 75 to 80 per cent of the elements of fertility in the food will be reclaimed again in the manure.

While I am not prepared to furnish the percentages of constituent fertilizers of pulp, I have given those of the ordinary feeds combined with it in stock rations. Since it stimulates feeding where available, these tables will suggest to the farmer the commercial value of his barnyard manures, and a careful saving and application of them will demonstrate the mutual relation between his feeding and cropping; also that sugar-beet pulp promotes both.

BRUSSELS CONFERENCE AND COUNTERVAILING DUTIES.

The most important event of the year affecting sugar production, an event which will be world-wide in its influence, was the action of the Brussels Conference. The results of the deliberations at this conference were the culmination of the natural desire of the several countries of Europe to relieve themselves from a serious economic muddle.

There are several countries in Europe in which sugar production is among the leading industries. In at least four of these countries, production of beet sugar largely exceeds home consumption. Each of these countries has been studying methods for encouraging production and exportation of sugar; each of them devised different plans, but all had the same end in view, viz, to pay a bounty on beet sugar exported to other countries. In order to derive a revenue to meet the bounties on exportation the Governments imposed large internal revenue taxes on sugar offered for home consumption. These taxes not only yielded sufficient funds to pay the export bounties, but contributed largely to the support of the respective Governments. Prior to the Brussels Conference, in France these internal excises were 60 francs per hundred kilograms (220½ pounds) on the greater part of the sugar produced. In Germany they were 20 marks per hundred kilograms (2.16 cents per pound). This was a tax on consumption of sugar; the people of France had to pay on sugar consumed 5.25 cents per pound, and the people of Germany had to pay on each pound of the sugar consumed 2.16 cents. This of necessity made the item of sugar in the daily living of these people quite expensive, ranging from 8 to 12 cents per pound, with the result that the consumption per capita annually in France is about 37.9 pounds, and in Germany 33.9, while in England and the United States, having no tax upon consumption, the per capita consumption of sugar is 88 pounds and 70 pounds, respectively. The present cost of sugar to consumers in the United States is about 5 cents per pound and in England about one-half a cent less. The bounty paid by Germany is direct, based on the amount of sugar exported in lots of more than 500 kilograms (1,102½ pounds), and is about 26 cents per hundred pounds of raw sugar. There are different bounties paid according to the grade exported, but this is the kind we import almost entirely. Our collector of customs requires in addition to the regular tariff[a] of $1.68½ per 100 pounds on German sugar, a countervailing duty of 26 cents, the equivalent of the bounty, making the tariff on the regular imported German raw sugar about $1.94½ per 100 pounds.

Prior to the Brussels Conference, France paid a direct bounty on raw

[a] The duty on raw sugar testing not above 96° polariscope is $1.68½ per 100 pounds. This is the standard grade on which prices are based.

sugar exported of 31 to 35 cents per 100 pounds on grades of sugar which we import, and so arranged the internal tax on consumption by crediting back tax on sugar exported as to pay a large indirect bounty. Our Treasury officials estimate this indirect bounty to be much larger than the direct. The excise requirement of 60 francs per 100 kilograms was based on a fixed return of 7¼ per cent of refined sugar. An additional yield above this paid an excise nearly one-half less. As a matter of fact the regular yield of refined sugar from the French beets is 10 to 11 per cent. Since all excises are rebated on sugars exported at the higher rate, viz, 60 francs per 100 kilograms (5¼ cents per pound) it is evident that on some of the sugar exported a larger rebate is given than the original tax paid. This difference is the "indirect bounty," and our Government has estimated it to be about 7.32 francs per 100 kilograms which, with the 3.50 francs "direct bounty," made 10.82 francs per 100 kilograms, equal to 95 cents per 100 pounds. This is the countervailing duty on French sugar required by our collector of customs in addition to the regular tariff of $1.68½ per 100 pounds, making a total duty of about $2.63½ per 100 pounds.

These countries all have heavy import duties in order to preserve their home markets for home-made sugars which carried heavy excises to meet public expenses and to pay these bounties on exported sugar. The German customs duty is 40 marks per 100 kilograms, or about $4.32 per 100 pounds. In France it is 60 francs per 100 kilograms of refined sugar, with a surtax on foreign sugars of 9 francs (in all about $6.04 per 100 pounds). The customs duty of Russia is 3 rubles per pood (about $4.28 per 100 pounds).

There are other beet-sugar countries than those mentioned which pay bounties on exported sugar. In effect their plans are quite similar, so that those given will suffice to illustrate the bounty system which has now been abolished by the agreements of the Brussels Conference, which was participated in by all European sugar-producing countries, except Russia. They subsequently exchanged ratifications, and bounties will cease September 1, 1903.

Russia's plan for encouraging export of sugar was more complicated. Each Russian sugar refiner is allowed to sell a certain quantity of sugar in the home market, called free sugar, upon which he pays an internal-revenue tax of 1.75 rubles per pood; this is equivalent to about $2.50 per hundredweight. On any excess of sugar produced by this refiner above the amount apportioned to him for sale he stands charged with an internal revenue twice as great as that on his allotted home sales, or 3.5 rubles per pood (about $5 per hundredweight). If he desires to export his excess he can do so under a permit from the excise office upon the return of a certificate with the custom-house export

mark; his excess holdings are then credited with the amount of sugar exported, relieving him of that amount of the duty of 3.5 rubles per pood. In this way he is encouraged to export. The Russian Government claims that it pays no bounty on exported sugar that is subject to the provisions of the Dingley Act, which requires all bounty-fed sugar coming to our ports to pay an additional duty over and above the regular tariff equal to the bounty paid by the Government where the sugar was produced. The general appraiser of customs has decided against the Russian claim; his decision was confirmed by the lower courts; it has recently been upheld by the Supreme Court of the United States; the Brussels Conference also held that these sugars were bounty-fed.

Russia refused to enter into the conference with other nations, claiming that its encouragement to sugar production is not a bounty on exports; that it is entirely a local affair with that nation and not subject to review by any conference of other nations. She still maintains this position.

The countervailing duty levied by the United States on imports of Russian sugar is 0.44 ruble per pood (about 63 cents per hundredweight) in addition to the regular tariff of $1.68½.

The Brussels Conference agreed that these bounties should cease September 1, 1903, provided the countries entering into the conference shall have indorsed its action, which they have since done. This does away with bounty encouragement in all the beet-sugar countries except Russia. The attitude of England occasioned this conference. She is a large consumer of sugar, but not a producer. Her markets were free for competition, with the exception of a recent war-measure duty requiring 1 cent per pound on imported sugar. Her consumption is about 1,500,000 tons annually. The effect of the export bounties paid in other countries was highly stimulating to production. The surplus sugars from these beet-sugar countries entered other markets highly subsidized, oftentimes selling at a price less than the actual cost of production. The market of England was the prize sought by all the sugar-producing countries. This placed the sugar-producing colonies of England at a disadvantage. The United States had put on an additional countervailing duty above their tariff sufficient to offset these bounties. England proposed to do the same, that her colonies might have a fair show in her markets. This situation would leave beet-sugar-producing countries with an abnormal production and bereft of the artificial means of disposal. The whole system tended greatly to overproduction. As a complication of this situation, local organizations in those sugar countries had combined in such a way as to control the production and markets of sugar. This can best be illustrated by the cartel of Germany. Since raw beet sugar

can not enter into direct consumption, the refiners organized what is known as the cartel, which allotted to each individual manufacturer his amount of production and sales and controlled the price. Whatever surplus over and above the home consumption was on hand was disposed of in England and other markets of Europe in competition with other European sugars and sugars from the Tropics. When these markets were supplied they could even sell, bolstered by the bounty, the balance in the United States at a profit, at less than the cost of production.

The effects of the Brussels Conference will be widespread throughout the sugar markets of the world. It will have a tendency to make the price of sugar more stable and undoubtedly to raise the same. It will cut down the world's production under the natural laws of supply and demand based on real factors of cost, with the artificial eliminated. This must necessarily benefit our home producers, whose product is not helped or stimulated by bounties. It will especially help our island possessions both in the East and West Indies. All the cane-sugar-producing islands of the Tropics have suffered immeasurably by the results of this world-wide cheapening of sugar by bounties. Unfortunately they had no large consuming class upon which to base a revenue supporting bounties on exports. Sugar production in these islands was very much depressed in consequence; in fact, it seemed in a fair way to obliteration. Porto Rico and the Philippines, along with the rest of these islands producing cane sugar, will be benefited by the restoration of a free, healthful competition, especially in the markets of England and other nonsugar-producing countries, or those partially supplying their demands, as is the case with the United States.

It is interesting to note the effect the Brussels Conference had on production in the sugar-producing countries during the past year. All of them realized that there was no longer a premium offered on overproduction. Without bounties, disaster was sure to follow if a retrenchment in output was not inaugurated. Russia, not signing the conference and contending that it had no bounty, was not similarly affected. I clip here an interesting item from the Modern Grocer, Chicago, Ill., January 1, 1903:

The German yield of sugar is still the largest of all; but for the present season, down to December 13, it is only 1,703,800 tons, against 2,293,296 tons the year before. Austria-Hungary stood second a year ago, with 1,291,000, but is now third, with only 1,060,800. France was third a year ago, but is now a poor fourth, with a reduction from 1,109,673 to 818,600. Belgium, Holland, Sweden, and Denmark follow in order, each with a considerable reduction. The total product of these seven countries a year ago was 5,407,393 tons. This season it is only 3,990,698, a reduction of 1,416,695 tons, or more than 26 per cent. Russia, on the other hand, has materially increased her production from 1,076,250 to 1,184,240 tons, an increase of 107,990

tons, or more than 10 per cent, thus rising from the fourth place a year ago to the second place, and threatening in another year or two to surpass Germany and take first place as the largest sugar producer of the world.

Outside of the stability that the Brussels Conference lends to the future of the sugar industry generally, there are some very important deductions to be made touching its effects. Undoubtedly in those countries in which sugar has been so heavily taxed the per capita consumption will gradually increase with cheaper sugar. Without the necessity of collecting large sums for the payment of bounty, these countries are materially decreasing their revenue tax. France has reduced hers from 60 francs ($12) to 25 francs (about $5) per hundred kilograms (220.5 pounds). Germany has reduced hers from 20 marks to 14 marks per hundred kilograms. In the future the cost of sugar to the consumers in those countries should be materially reduced.

The conference is liable to produce some startling results touching other products. This high cost of sugar in France and Germany practically prohibited the manufacturing of some other things requiring sugar as a raw product. To-day England produces about 70 per cent of the jams and fruit preserves consumed in Europe by importing and working up fruits and sugar from France, and building up a trade in jams and preserved fruits in France and other countries as a result of this unnatural system of taxation. France is probably the leading nation of the world in the production of fruits entering into preserves and jams. Is it not likely that France will undertake to sustain the high production of sugar she has stimulated, not only by an increase in consumption, but by using it in building up a preserving industry? Furthermore, while France, under the new arrangement, requires 25 francs per 100 kilograms as internal revenue on the production of sugar, it only requires a revenue of 7.5 francs for the production of glucose. France has called a council of her sugar experts desiring information as to the wisest course to meet this serious situation brought about by the Brussels Conference. Out of this has grown the recommendation that France go into the jam and preserving industry, employing glucose as a raw material in the place of sugar. She may take the place of England in supplying preserved fruits and jams, and England in gaining "fair play" for her colonies in sugar markets may have lost her strategic position in making preserved fruits and jams.

From the above it appears that in requiring an article to enter into home consumption at a high cost to benefit exports, a government may deprive its people of some of the comforts and necessities of life, and starve some industries to build up others.

The following table (p. 76), showing the fiscal legislation of Germany, France, and Russia affecting raw sugar, was prepared in the Division of Foreign Markets, Department of Agriculture, and is appended to the foregoing discussion for reference.

Legislation of Germany, France, and Russia in regard to raw sugar.

GERMANY.

	Marks per 100 kilograms.	Dollars per 100 pounds.
Customs duty	40.00	4.32
Excise:		
Consumption tax[a]	20.00	2.16
Manufacturing tax[b] (not refunded on exportation)	.10	.01
Export bounty on raw sugar not less than 90° polariscopic test	2.50	.27
Cartel aims to keep the inland price of raw sugar at 25.50 marks per 100 kilograms, the increase above the world price not to exceed	6.80	.73
Countervailing duty imposed by the United States on raw sugar not less than 90° polariscopic test	2.40	.26

FRANCE.

	Francs per 100 kilograms of refined sugar.[c]	Dollars per 100 pounds of refined sugar.[c]
Customs duty:		
Regular[d]	60.00	5.25
Surtax (on foreign sugars)[e]	9.00	.79
Excise (not levied on sugar destined for export):		
Consumption tax, according to yield[f]—		
Sugar obtained up to the legal yield, 7.75 kilograms of refined sugar per 100 kilograms of beets	60.00	5.25
Sugar obtained above the yield of 7.75 kilograms and not above 10.50 kilograms	30.00	2.63
Sugar obtained above the yield of 10.50 kilograms	45.00	3.94
Manufacturing tax on raw sugar	1.00	.09
Export bounty (direct) on sugar testing less than 98° in the case of beet sugar or 97° in the case of colonial sugar and not less than 65°	1.11	.10
Countervailing duty imposed by the United States (on the same grade of sugar)	[g] 10.82	.95

RUSSIA.

	Rubles per pood.	Dollars per 100 pounds.
Customs duty	3.00	4.28
Excise:		
Consumption tax—		
Free sugar[h]	1.75	2.50
Other sugar	3.50	4.99
Refining tax	.005	.007
On exportation the excise tax is refunded and a certificate (having market value) is issued. This certificate permits an equal quantity of sugar to enter domestic consumption on payment of excise on free sugar.		
Countervailing duty imposed by the United States on sugar less than 99° and not less than 88°	.44	.63

[a] Sugar exported under Government supervision is exempted from this tax. Sugar produced by factories above their official allotment (contingent) is subject to an additional tax of 2.50 marks per 100 kilograms (27 cents per 100 pounds).

[b] In case of factories producing not more than 4,000,000 kilograms annually this tax is 0.10 mark per 100 kilograms (1 cent per 100 pounds). For each increase of 1,000,000 kilograms, or fraction thereof, in the annual production, the tax on the entire product is increased 0.025 mark per 100 kilograms (0.3 cent per 100 pounds).

[c] To estimate the yield in refined sugar, there are deducted from the absolute richness (as indicated by the polariscope) four times the quantity of ashes and twice the quantity of glucose. The yield is multiplied by the actual weight of raw sugar, less 1¼ per cent allowed for loss in refining.

[d] Sugar imported from Martinique, Guadeloupe, and French Guiana is allowed a reduction of 2.25 francs, and that from other French colonies a reduction of 2.50 francs per 100 kilograms of refined sugar. Sugar imported from all French colonies is allowed a deduction for waste equal to the average surplus above the legal yield obtained by the domestic industry during the previous season; such waste is dutiable at 30 francs per 100 kilograms.

[e] Levied on actual weight. This surtax is not refunded in case of the reexportation of European sugar.

[f] Instead of these rates the manufacturer has the option of paying on 85 per cent of the actual production 60 marks per 100 kilograms ($5.25 per 100 pounds), and on 15 per cent, allowed as waste in manufacturing, 30 marks per 100 kilograms ($2.63 per 100 pounds).

[g] Apparently equal to 3.50 francs direct and 7.32 francs indirect bounty. The Treasury Department has not reduced its estimate since the French law was modified in August, 1902.

[h] Levied on the quantity of sugar allotted to each factory by the Government.

HISTORY OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES.

There are two distinct epochs in the history of the sugar industry in the United States—the first, 1830 to 1888; and the second, 1888 to the present. One is characterized by its failures, and the other by its rapid success. To those unacquainted with this history, the statement will be taken with surprise that we began the manufacture of sugar from beets seventy-three years ago, beginning when the world's production of beet sugar was in its infancy and the industry was battling for existence. At that time but little progress had been made in the methods, implements, and principles of agriculture. "The Great American Desert," bounded on the east by the Missouri River, rested as securely on the maps as did the great Rocky Mountain range west of it. In our agriculture science had no place worthy of the name. Our people generally thought the prairies of Iowa and Illinois and the farther West fit only for grazing. Farming lands must be sought in the timbered areas. These were cleared at tremendous labor and expense in order to secure cultivated crops. The idea of intensified farming resulting in the production of meat, butter, cheese, poultry, eggs, and vegetables was confined to the East, and was destined to work its way westward when conditions would permit.

Three facts contributed to the failure of our first efforts in producing beet sugar:

First. In the production of the beet crop and in the manufacture of sugar the methods were crude, and there was a lack of definite scientific information.

Second. Most early efforts in the production of beet sugar were, unfortunately, made in parts of our country having conditions which were not the best.

Third. Production of cane sugar, especially in the Tropics, had had a long trial, and the methods were thoroughly matured. Not nearly so much science, care, and cultivation is required with cane as with beets. Men with less intelligence can accomplish more through nature's help. Consequently, cane-sugar production was too strong a competitor for the new industry. The cost of beet-sugar production was so out of proportion to that from the tropical cane fields that these first factories in the United States could not survive.

The work of fighting the battles of the new industry was necessarily left to the older, better equipped countries of Europe, whose conditions were more settled and whose recourse to scientific help was more common. These countries, through a long, tedious struggle, gradually lessened the cost of beet-sugar production; bred sugar beets containing a higher percentage of sugar and purity, yielding a greater tonnage per acre; modified and improved their processes of extracting the

sugar from the beets, until about eighteen years ago the beet-sugar production of the world, for the first time, equaled the production from cane. From that time on the beet-sugar product rapidly increased over that from cane, until, in 1901, the total beet-sugar production of the world was 7,011,164 tons, while that of cane was only 4,042,575 tons. In this short period of time beet sugar had reached 63.4 per cent of the entire world's production.

Shortly after beet-sugar production had overtaken that from cane in the world contest the United States began to renew active interest in the former, and the result has been a most flattering success. No other industry has progressed with more rapid strides or enjoys to-day brighter prospects for the future. The factors that combined to bring about this magnificent result are four:

First. The time was ripe; our conditions were better understood; our efforts were more intelligently directed; we were better acquainted with the soils and locations adapted to this industry, and our tendencies were toward intensive agiculture.

Second. The cost of production of both beets and sugar had been so much lowered that the industry was no longer working under difficult competition with cane sugar.

Third. While Europe had demonstrated that, by high cultivation and intelligent effort, sugar beets could be made to compete profitably with cane, it was also evident that we possessed advantages even superior to those of Europe itself. Our land values are lower. The values of the German beet lands are $500 to $800 per acre. Ours can be made as productive with their natural fertility as those of Europe maintained at a high cost for commercial fertilizer.

Fourth. The most potent reason that can be given for the rapid ascendency of beet sugar over cane is the fact that the habitat of the sugar beet in the most highly civilized portions of the world brought to the manufacturer that concentration of the highest possible scientific investigation and achievement in the manufacture of the sugar product.

The early history of beet-sugar production in this country is a story filled with trials, struggles, and hardships. Enterprises were launched with hopeful expectancy and enthusiasm, only to find a final resting place in the junk piles. It is pathetic to study these abortive attempts, all of them illustrative of the courage, energy, and endurance of our pioneers in establishing infant industries, which have grown to be wonders of the world, objects of our national pride, the foundation of our wealth, and mainspring of our prosperity. These efforts were pursued with the tenacity and energy characteristic of the upbuilding of the Nation itself; without despondency or discouragement, these pioneers saw one failure follow another, leaving its legacy of experience, pointing out the shoals and dangers and making final success possible.

I find that very few are aware of the great losses incident to the first attempts in establishing beet-sugar industry. By corresponding with parties who have personal knowledge of the facts and from other available sources,[a] I have collected the following information concerning the early attempts to establish the beet-sugar industry in the United States.

PERIOD OF DISASTER, 1830 TO 1888.

1830.—In Philadelphia two gentlemen by the name of Vaughn and Rondalson erected the first American beet-sugar factory. The career of this enterprise was short. It produced during the year a few hundred pounds of sugar and then succumbed to the inevitable. The probabilities are that lack of knowledge concerning the growing of beets, lack of skilled help in the factory, and the poor quality of the sugar produced all contributed to the downfall of this enterprise.

1837.—One Dr. Hall, of Massachusetts, of an investigating turn of mind, had been traveling in France and became interested in the beet-sugar industry. He returned home, planted an acre of beets and produced sugar from them, probably by open evaporation. His product was exhibited at the meeting of the agricultural society, and he was awarded a prize of $100. This stimulated Mr. David Lee Childs, who had studied beet-sugar production in Europe, to erect a factory at Northampton. He had conceived a peculiar idea, which we hear promulgated even to-day, i. e., that of first drying the beets. In this manner they can be stored away and worked at pleasure, since the moisture is out of them and they are not so much subject to decay or deterioration. The crop of beets was about 13 to 15 tons per acre, yielding about 6 per cent of sugar, the estimated cost of producing the same being about 11 cents per pound. This factory, after producing about 1,300 pounds of sugar, was abandoned in 1840.

1852.—From the beginning of their history until recently the people of Utah lived within their own resources. In the pioneer days they endured many hardships, and, compelled by their location and environments, strove to build up the means of supplying their own wants. In 1852 Brigham Young, the head of the Mormon Church, conceived the idea of bringing a beet-sugar factory to Salt Lake City. In this attempt he was assisted principally by John Taylor, then a missionary to France, afterwards president of the Mormon Church. A company was organized in Liverpool known as the Deseret Manufacturing Company, with a capital of £50,000. A factory was purchased, placed on shipboard at this port and shipped from England to New Orleans, and thence by river to Fort Leavenworth, Kans., where

[a] I am indebted to Mr. Truman G. Palmer, of Chicago, Ill., for some of the data contained in this account.

it was unloaded. At Council Bluffs, Iowa, 52 wagons were specially constructed to haul the heavy machinery overland through the wilds and over the mountains to its far away destination. Long trains of wagons, pulled by several hundred oxen and manned by three score or more of men, started on this perilous trip. It pursued its way for days through hostile Indians, depending largely on the resources of the country for supplies, and was finally caught in a blizzard in the mountains, where many of the oxen and several of the men perished.

I am indebted to Mr. Horace G. Whiting, secretary and treasurer of the Utah Sugar Company, for the following account of this expedition:

The only record I have been able to find as to the cost of the machinery is a statement in the Life of John Taylor, by B. H. Roberts, which says that "Mr. Taylor had the machinery for the intended sugar works made in Liverpool by Faucett, Preston & Co. at a cost of $12,500. It was first-class machinery; the very best that could be obtained."

I have no way of telling what the cost of transportation was, but it must have been enormous, as the freight rate was then $800 a ton from the Missouri River to Utah.

The name of the vessel which brought the machinery from Liverpool to New Orleans was the *Rockaway*. It arrived in New Orleans the latter part of April, 1852. An account of the tremendous difficulties of transporting it over the Plains in wagons drawn by oxen is contained in the personal diary of Mr. Elias Morris, which I have had the pleasure of reading recently. The narration is identical with many of the stories of the pioneers of those days.

Mr. Morris says that Elder Taylor engaged a boat to carry the machinery from New Orleans to St. Louis. At that point he engaged another to transport it to Fort Leavenworth, where it was unloaded. He then went to Kanesville (Council Bluffs) to bring down the wagons which had been made to carry the machinery. This required considerable time, and, returning to Fort Leavenworth, they had another long wait for the company's cattle, but on July 4, 1852, they finally started for the West. The first day they made but 4 or 5 miles, but in that time several axletrees were broken, as the wagons had been badly made of green timber and were very heavily loaded. Some of the cattle, too, proved very wild. These delays constantly occurred; a great many cattle died on the way, and the result was that before three-quarters of the journey to the Salt Lake Valley had been accomplished, the company ran short of provisions. Their store was replenished by killing buffalo on the Platte River. Snow fell at the Sweetwater and the storm was so severe that the cattle were stampeded and before they could be found 10 had died. Eighty went astray. Then part of the train had to proceed, leaving the heavier wagons and a company of 6 young men behind to forage for their own food and recover the lost cattle. This they ultimately did, following after the main company. They missed the road, however, and went on toward Oregon until they struck the Green River, so that another long delay elapsed before the two companies were reunited.

The arrival in Salt Lake took place in the beginning of November, after a laborious journey of four months. Mr. Morris's journal adds that Elder Taylor had previously appointed Philip De Lamar, formerly of Jersey, England, to be captain of the company, and Mr. Morris himself was a captain of the first 10 and chaplain.

Mr. Morris's diary continues that the machinery was first taken to Provo, as that was the place agreed on for the location of the sugar factory. It took three weeks to travel a distance of 40 miles. By that time it had been decided to dissolve the

FIG. 1.—WAGONS LOADED WITH BEETS GOING ONTO DUMP FOR UNLOADING INTO CAR.

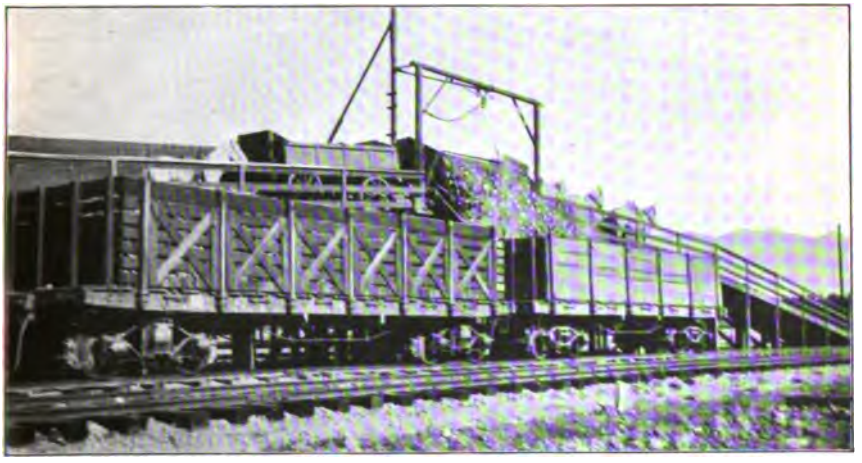
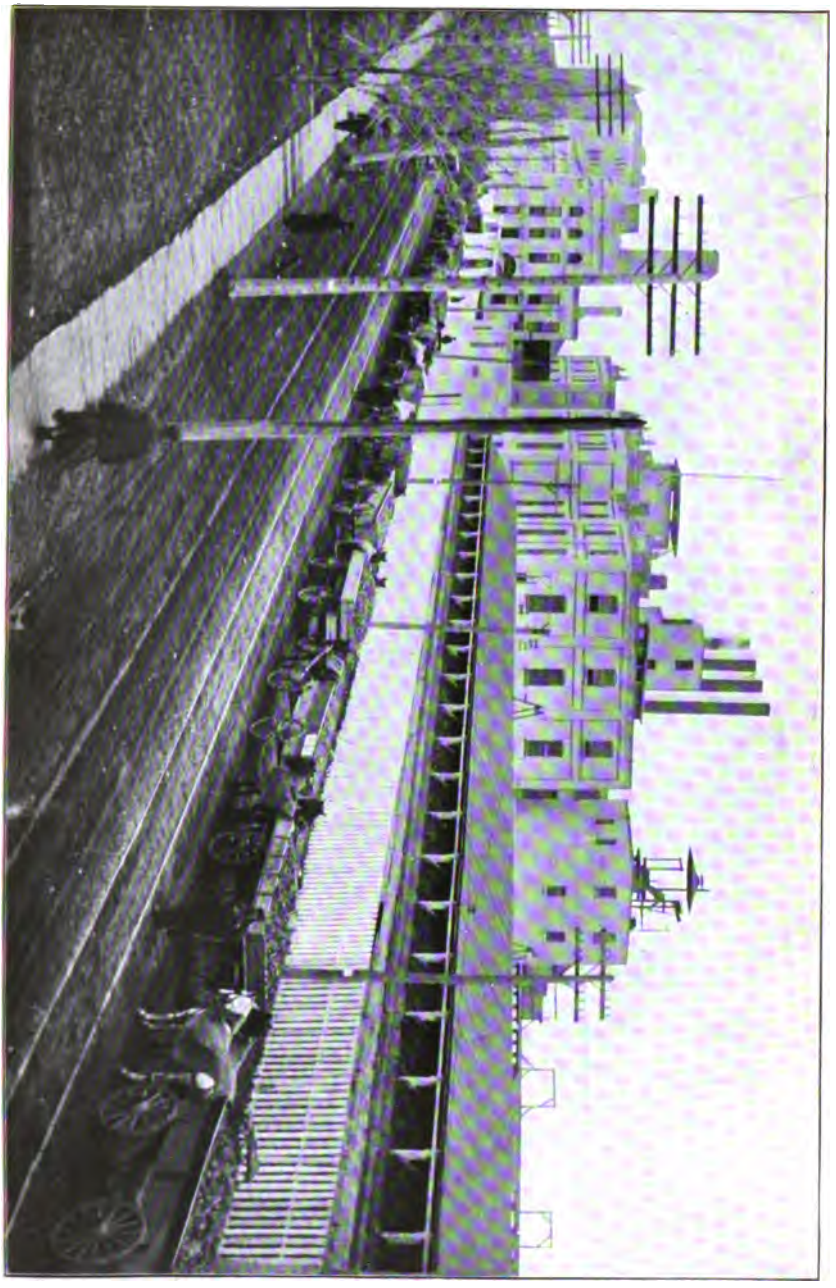


FIG. 2.—DUMPING THE BEETS INTO THE CAR.

FIG. 3.—WAGON AFTER BEETS HAVE BEEN DUMPED INTO CAR, NEAR OXNARD, CAL.

PLATE IV.



FACTORY AT BAY CITY, MICH., WITH STRING OF WAGONS WAITING TO BE UNLOADED.

Deseret Manufacturing Company and the property was turned over to the Mormon Church. This seems to have ended Mr. Morris's connection with the first attempts to make sugar here until 1889, when the present Utah Sugar Company was organized; he was made the president and continued in that position until the time of his death.

Other authorities state that the mill was finally erected in what was called Sugar-House Ward, now a suburb of Salt Lake City, but for various reasons no beet sugar was ever made.

I am unable to tell what was the estimated capacity of the factory.

Roberts's Life of Taylor says that "the machinery was put in operation, but owing to a lack of skilled workmen to take charge of the various branches of the business the production of sugar was unsatisfactory, and at the instance of President Young the enterprise was abandoned."

W. C. A. Smoot, one of the original Mormon pioneers, now a resident of Sugar-House Ward, to whom I applied for information, says that a part of the sugar machinery arrived here in 1852, the remainder in 1853. No sugar was made; nothing but molasses. In 1854 the plant started up about the middle of November and ran until about the latter part of March, 1855, making only molasses. He adds that the beets had sprouted badly, which was the reason they could not be worked.

From other sources I learn that there was not at that time in this country any means of refining sugar or of extracting the potash salts which the molasses contained.

Some of the machinery of this factory is to be found yet lying around the junk and waste heaps, monuments of at least one failure made by this thrifty, industrious people.

1863.—I have been unable to learn of any other attempts to make beet sugar in the United States until 1863, when two Germans, one a capitalist, Jacob Bunn, and the other a manufacturer, Mr. Gennert, erected a factory at Chatsworth Park, Ill. This factory continued in operation until 1870, producing from 250 to 400 tons of sugar per year. The beets yielded about 8 per cent sugar. Lack of experience, bad management, and the inability of the factory to secure good water at Chatsworth Park contributed to its final failure. About $175,000 was expended in this effort. Mr. Bunn, who was a banker at Springfield and the principal stockholder, came into possession of the factory and moved the same to Freeport, Ill., where it was operated for a year by the Germania Beet Sugar Company; then it was moved to Blackhawk, Wis., to be operated as a cooperative concern. Here it suffered from lateness in completing the factory, poor crops, and failure of the water supply, and in consequence seems to have ceased operations in 1871.

1869.—In 1869 two Germans, Bonnesteel and Otto, erected a small factory at Fond du Lac, Wis., costing about $12,000. This enterprise was abandoned the next year, part of the machinery going to Blackhawk and part to Alvarado, Cal., where these parties joined with Mr. E. H. Dyer in constructing a factory.

Of this Fond du Lac enterprise it can be said that it was successful. Though cramped for means, its results were so favorable that it attracted the attention of capitalists of Philadelphia, who offered strong inducements to these parties to go there, but under the superior

offers of capitalists in California they moved to that State, abandoning what appears to have been a fair start in the right place, as all evidence to-day points to the favorableness of this locality.

1870.—An attempt was also made in New Jersey to manufacture sugar, ending in failure.

In this year Mr. Bonnesteel and Mr. Otto moved their plant from Fond du Lac, Wis., and joined with Mr. E. H. Dyer, organizing the Alvarado Sugar Company, constructing a large factory at Alvarado, the machinery for which, other than that shipped from Fond du Lac, was manufactured partly in San Francisco and partly in Germany. This factory operated until 1874, was closed down, and the machinery moved to Soquel, Cal., where it operated one year, under the management of Bonnesteel and Otto, the company failing in 1876.

During the year 1870 a factory was started by the Sacramento Valley Company at Sacramento, Cal., having a daily capacity of 300 tons of beets, at a cost for construction of $300,000. This factory operated until 1875. The machinery was sold to a company in Alvarado, Cal. This factory did not pay, for the reason, it is said, of the incompetency of the superintendent. It produced during the first and second seasons from 700 to 800 tons of sugar. During the last three seasons the plant was used in making molasses and rum.

1873.—A factory was erected at Ileton, Cal. It was of small capacity and inadequate for the production of sugar. The beets produced for it were poor and small. This factory operated several years, was closed down for a period, and attempted to make sugar again in 1880. It was finally closed up and most of its machinery sold for other purposes.

1878.—Up to this time no successful factory had been established. For several years preceding this date the annual production of beet sugar in the United States had fallen below 100 tons. Stimulated by a bounty of 1 cent per pound, in 1878 a refinery at Portland, Me., put in machinery for testing the feasibility of manufacturing sugar from beets. A beet-sugar company was organized for the purpose of exploiting this project. About $60,000 were expended, and trials covering a period of three years were made. The beet-sugar department of the refinery had a capacity of about 150 tons of beets daily. In 1881 this feature of the business was abandoned, largely for the reason that the farmers refused to grow the beets.

1879.—Mr. E. H. Dyer, of Alvarado, Cal., armed with the experience of his first failure at this place, and with the newer, larger, and better machinery of the factory shipped from Sacramento, started again in the manufacture of beet sugar, stimulating the organization of the Standard Sugar Refining Company. This factory had a capacity of 300 tons. The earlier effort had given the farmers some experience

in growing sugar beets. It had also given Mr. Dyer a great deal of information on the things to be avoided in the manufacture of sugar, as well as on the things to be done. His second attempt was under more favorable circumstances in every respect. Not only was the factory better equipped and more competent in every way, but it started with better help. This is the only one of all the factories started prior to this date which is still engaged in the production of sugar. It has the distinction of being the first successful pioneer factory. It is the spark in the smouldering ruins whose latent vitality caught the morning breeze of a new industrial activity, which fanned it into the flame of successful beet-sugar production in the United States. Its capacity has been enlarged from time to time, until it is now capable of working 1,100 tons of beets daily.

I reproduce here from a carefully prepared article by Mr. Truman G. Palmer a recapitulation of losses through failures prior to our period of success and including some more recent failures:

But a very indefinite estimate can be made of the financial losses incurred during the experimental stages of this industry.[a] The following table is given for what it is worth, nearly all of the larger losses being taken from authenticated figures of the companies operating the plants:

Losses through failures in the beet-sugar industry in the United States.

1830, Philadelphia, Pa	$100,000	1875, Soquel, Cal	$75,000
1838, Northampton, Mass	100,000	1878, Delaware	100,000
1863, Chatsworth Park, Ill	175,000	Portland, Me	100,000
1869, Fond du Lac, Wis	35,000	1892, Staunton, Va	100,000
1870, Freeport, Ill	75,000	1896, Eddy, N. Mex	200,000
New Jersey	100,000	Menominee Falls, Wis	200,000
Alvarado, Cal	250,000	1897, Rome, N. Y	200,000
Sacramento, Cal	75,000	1899, Pekin, Ill	50,000
1871, Black Hawk, Wis	75,000		
1873, Ileton, Cal	100,000	Total	2,110,000

The actual amount of money lost in the United States in experimenting with beet roots before the industry became established on a paying basis will never be known.

The loss in buildings and machinery represents but a small portion of the total amount of money which was swallowed up in experiments.

Five millions of dollars probably would not cover the direct and indirect financial losses of factory and field in the quest for European technical knowledge, to say nothing about the blasted hopes of communities and the bankruptcy of interested individuals.

The losses arising from nearly sixty years of universal failure have been more than compensated by the all but universal successes of the past ten years.

As in all other phases of life, the pioneers have paid the usual penalty of progressiveness, and to-day we are profiting by their failures.

1888 was the first year in our history when home productions of beet sugar exceeded 1,000 tons, and it terminated a series of disasters which had lined our pathway for over half a century.

[a] No attempt has been made to estimate the loss involved in Mormon failure of 1852.

The first requisite of a successful beet-sugar factory is a reasonable supply of good beets. It took eighteen years of struggling in Alvarado to overcome the apathy of the farmers, who at last began to realize that beet culture was a profitable line of agriculture.

The "factory expense" at this time had been reduced to $6.57 per ton of beets; the farmers were paid about $5 per ton, making a total cost to the factory of $12.57 per ton. The beets were high grade, the price of sugar 7 cents per pound, and the factory was able to make a profit of $1.50 per ton of beets worked.

Ten years later the Alvarado plant had reduced the "factory expense" from $6.57 to $2.71 per ton of beets, and the capacity of the factory had been increased from 200 to 800 tons of beets per day.

PERIOD OF SUCCESS, 1888 TO THE PRESENT.

Before going into the detailed history of factories representing the practical success of the beet-sugar industry I wish to refer first to some of the men who have been instrumental in bringing it about. I have already spoken of the elder Dyer, who practically belonged to both periods. He is often referred to as "the father of the industry."

Mr. Henry T. Oxnard, who had been identified with cane-sugar production, and had also made a study of beet-sugar production, in 1890 organized a company which built two factories in Nebraska. He has continued to work along this line until he is now at the head of a company which owns and operates five large factories and is maturing plans for others. (See Pl. III.)

Thomas R. Cutler, of Lehi, Utah, a pioneer in this work, early became impressed with the future of the beet-sugar industry, and interested the Mormon people in the possibilities of beet-sugar production.

He early discovered that at the time beets should be delivered at the factory there was a shortage in freight cars, necessitated by the demands for transportation of crops and of mining products. This induced him to install, at three different places, diffusion stations for extracting the juice. One of these stations is 20 miles distant from the main factory, and the nearest one is 10 miles. Pipe lines are buried in the ground, through which the juice is pumped from these diffusion stations to the main factory, doing away with the necessity of transporting the beets either by team or by rail. He has installed a permanent, practical, cheap method of delivering to the factory the juice of the beets. This innovation of pipe lines was met with the assurance of experts that it would be a failure. The pipe-line system had been tried in Europe and "found wanting," but it happened that it had never been tried by a "Yankee" before, and now the experts will have to reverse their verdict and say that it is a pronounced success.

Mr. Cutler found that fertilizer could be introduced into the Utah beet fields to a good advantage; at the same time he discovered that two islands in the Great Salt Lake, which had been occupied by two different species of birds (cranes and pelicans) as rookeries and places

for rearing their young, abounded in deposits of guano. It is quite generally believed that the Great Salt Lake contains no animal life, but there is a species of shrimp inhabiting this lake, tons of which are washed up on the shores of these islands, contributing also to this deposit of fertilizing matter.

Mr. Claus Spreckels of San Francisco, "father of sugar production in the Hawaiian Islands," several years ago transferred his field of active operations in sugar production from the Hawaiian Islands to the State of California, erecting a factory of large capacity at Watsonville, which he followed soon after with another of 3,000 tons capacity at Salinas. Mr. Spreckels has the distinction of possessing the largest beet-sugar factory in the world. The enormous demand of this factory can be indicated in no more graphic way than by stating that it is capable of working every day a train load of beets over 1 mile in length.

There are now in the United States many firms prepared to design and construct sugar factories of the latest and most improved pattern. We have manufacturers of machinery in our large cities thoroughly equipped to install the best and most modern machinery for manufacturing beet sugar. We have capitalists and promoters working for the establishment of new factories to develop our resources in beet-sugar production.

The following is the chronological order in which beet-sugar factories have been established since the "period of disaster" closed, together with a statement of the capacity of each:

1888.—The year 1888 marks the dividing line between failure and success in the production of beet sugar in the United States. In this year Mr. Claus Spreckels, of San Francisco, one of the original sugar producers of the Hawaiian Islands, and probably the most important, constructed a beet-sugar factory at Watsonville, Cal., with a daily working capacity of 300 tons of beets. This factory is notable as the first in the United States which has had continuous success from the beginning.

1890.—In 1890 Mr. Henry T. Oxnard erected his first factory, of 300 tons capacity, at Grand Island, Nebr. The operations of this factory and the farming conditions surrounding it, have probably contributed more than any other source to all the country east of the Rocky Mountains, in furnishing information as to the practical results of beet-sugar production.

1891.—During this year three factories were constructed at places and with capacities as follows: Norfolk, Nebr., 350 tons; Lehi, Utah, 350 tons; Chino, Cal., 350 tons.

1892.—The factory built by Mr. O. K. Lapham, of New York, at Staunton, Va., and operated for two years, accidentally burned to the

ground in 1895, and was never rebuilt. The beets grown for this factory were very good, yet it is not a locality considered favorable for this industry.

1896.—In 1896 a factory, the machinery of which was originally built and operated in France, removed to Canada, and then to Eddy, N. Mex. This factory had a daily capacity of 200 tons. It operated two seasons and closed down, since which time it has not been working. On February 3, 1903, for some unknown cause, it burned to the ground without insurance. This factory was one of the mistakes of beet-sugar manufacturing in the United States. In type of machinery and size it was unfit to compete with more modern concerns, and was a failure both in Canada and New Mexico.

The factory built at Menominee Falls, Wis., in 1896, was an absolute failure from the beginning; the crop of beets grown for it rotted in the silos. The causes contributing to this failure were due to faulty construction rather than to any natural causes or conditions incident to the locality, as is shown by the fact that a very successful factory is in operation there to-day. The new factory is made up of the old building, with entirely new equipment of modern machinery. It was found necessary to dispose of all the machinery of the old factory as absolutely worthless for this purpose.

1897.—A factory was constructed at Los Amitos, Cal., having a daily capacity of 350 tons. This was one of the first enterprises depending on the production of beets on new and unsubdued lands. The land surrounding this factory had been one of the oldest, largest, and best known sheep ranges in California. Sugar beets were successfully grown and the factory was able to declare a substantial dividend the first year.

In 1897 a small plant of French pattern was moved from Farnham, Quebec, to Rome, N. Y.; was operated a couple of years, and then ceased. This was also an old-style, second-hand factory of French design, and while in operation in New York maintained but slightly over 100 tons daily capacity. I understand that it is to be finally dismantled and the machinery disposed of.

1898.—A beet-sugar factory of 1,200 tons daily capacity was installed at Crockett, Cal., by the California and Hawaiian Refining Company. This company had been operating a plant at that place, refining Hawaiian sugars. It conceived the idea of installing a department for manufacturing and refining beet sugar during the natural campaign for working sugar beets, and devoting the rest of its time and energies to refining Hawaiian cane sugar. The association of these two industries is the unique feature of this concern; the beet sugar furnishing a raw product for the refiner, increasing the supply of the refinery to that extent. A great many plans have been proposed, involving the use

of the machinery of beet-sugar factories for a longer period than that afforded in the natural campaign for working beets. This combination of manufacturing and refining on the coast, using the raw sugars of the Hawaiian Islands and the raw sugar made from beets in the factory itself, or in others, is suggestive of what may be done by other western beet-sugar concerns.

The introduction of the beet-sugar industry now became very rapid. I shall simply record place, capacity, and the date of the establishment of later factories:

Factories built during five years, 1898–1902, with capacities.

	Tons.		Tons.
1898, St. Louis Park, Minn	350	1899, Fremont, Ohio	350
La Grande, Oreg	350	Lyons, N. Y	600
Ogden, Utah	350	Sugar City, Colo	500
Betteravia, Cal	500	Grand Junction, Colo	350
Bay City, Mich	500	Rockyford, Colo	1,000
Binghamton, N. Y	300	1900, Alma, Mich	600
1899, Pekin, Ill [a]	500	1901, Logan, Utah	400
Oxnard, Cal	2,000	Loveland, Colo	1,000
Salinas, Cal	3,000	Menominee Falls, Wis. [c]	500
Leavitt (Ames), Nebr	500	Saginaw, Mich	600
Waverly, Wash	350	Lansing, Mich	600
Bay City, Mich	750	Salzburg, Mich	400
Rochester, Mich	500	1902, Sebewaing, Mich	600
Caro, Mich	600	Carrollton, Mich	800
Kalamazoo, Mich	500	Mount Clements, Mich	600
Holland, Mich	350	Croswell, Mich	600
Benton Harbor, Mich. [b]	350	Eaton, Colo	600
Marine City, Mich	350	Greeley, Colo	800

Factories now building for campaign of 1903.

	Tons.		Tons.
Charlevoix, Mich	600	Fort Collins, Colo	600
Mount Pleasant, Mich	600	Windsor, Colo	600
Menominee, Mich	1,000	Longmont, Colo	600
East Tawas, Mich	600	Gardner, Utah	1,200
Owosso, Mich	1,000		

In presenting the above list of sugar factories, arranged according to the date of installation and giving the daily capacity at the beginning, I must call attention to the fact that a great many of these have since greatly increased their working capacity. I also call attention to the pertinent fact that recent factories are starting with much larger capacities. We are increasing the sugar output of this country not only through a large increase in the number of factories but

[a] Failed as a beet-sugar factory; afterwards run as a glucose factory.

[b] Failed, and in 1901 was dismantled and removed to Canada.

[c] The factory originally built here in 1896 was a failure; it was rebuilt in 1901 and is now in successful operation.

through building larger factories and enlarging the capacities of those already built.

It must not be assumed that all of the factories built during this period of successful operation have proven successful. Some of these, from one cause and another, have shared the fate of those built during the period of failure.

In 1899 a factory was constructed at Pekin, Ill., of 500 tons daily capacity. This factory operated one year. The surrounding country produced a crop of beets for the second campaign, but the company concluded not to continue longer in the production of beet sugar and converted the concern into a glucose factory, and the beets grown for 1900 were sold to the factory in Ohio and the one at Benton Harbor, Mich. There were probably two reasons contributing to this change:

First. The season during which the factory operated was not a favorable one for growing sugar beets. It was the trial year of the farmers on an entirely new crop. The beets were small as a rule and not high in their sugar content.

Second. This particular district is one devoted to extensive production of glucose and whisky. Parties interested in the beet-sugar factory were experienced in both of these other enterprises. The possibilities of producing glucose were well understood and those of sugar beets were indefinite. The first year's experience was not encouraging to sugar production.

In 1899 a sugar factory of 350 tons capacity was installed at Benton Harbor, Mich. It operated two years under unfavorable circumstances. It was late in building and completion, and the first year was not favorable to sugar-beet growing. The farmers were discouraged in their first attempts. The country surrounding this factory is devoted to vineyards and peach orchards, both of which are very profitable, producing fruit of a very fine and delicate flavor, which finds a ready and near market in Chicago and other cities adjacent. The farmers were so successful in producing peaches and grapes that they were loth to change to production of sugar beets; they were more inclined to plant all available lands in orchards and vineyards. The factory found it very difficult to procure a sufficient supply of beets, and in 1901 it was dismantled and removed to Canada, to engage in beet-sugar production there.

A factory was built at Grand Junction, Colo., in 1899, having a daily capacity of 350 tons. This factory has not been operating for the last two years, but must not be classed among the failures. It is a factory of modern make and equipment, and built throughout of brick, cement, and steel, and is located in the very fertile valley of the Grand River. This is probably one of the best fruit-producing districts in the Rocky Mountains, the whole enthusiasm and energy of

the people having been thrown into this enterprise. It is one thoroughly understood by the farmers and the results of which are very satisfactory. The sugar factory experienced from the start a difficulty in getting the farmers to give up fruit growing and devote lands to beet growing, which with them was new and untried. Practically the only land that could be secured was the new wild land. The farmers undertook here to bring this soil into cultivation by growing sugar beets for the first crop. It is well understood that sugar beets are not good as a pioneer crop, and while it may be said that the factory at Grand Junction failed to secure a sufficient supply of good beets, yet I am not at all prepared to say that the older and better cultivated lands of Grand River Valley will not produce a first-class crop of beets if given a fair chance. I expect to see this factory a thriving concern. Most of the soils around Grand Junction are gradually being brought under cultivation, and their condition is gradually becoming better for growing sugar beets or any other crop.

AN INSTRUCTIVE COMPARISON.

Comparing the status of the beet-sugar industry in 1903 with its status at the beginning of 1897, when the Department's work of fostering beet-sugar industry was renewed, and which marks the beginning of the great activity in factory building, I offer the following data:

In 1897 we had 8 factories, with capacities as follows:

	Tons.		Tons.
Grand Island, Nebr	300	Rome, N. Y	200
Norfolk, Nebr	300		
Alvarado, Cal	800	Total daily capacity, beets	3,750
Watsonville, Cal	800	Average daily capacity per factory, beets	469
Chino, Cal	800		
Los Alamitos, Cal	350	Total daily capacity for production of sugar	426
Eddy, N. Mex	200		

Working up to their full capacities for a campaign of 88.2 days (the average length of campaign in 1901), these factories would require annually 330,750 tons of beets, having a value of $1,323,000, and would produce 37,573 tons of sugar, having a retail value at 5 cents per pound of $3,757,300.

Counting three diffusion stations as factories, we had ready for operation in the campaign of 1902, 46 beet-sugar factories. Adding to this list 9 now building for the campaign of 1903, gives us a total of 55 factories, as compared with 8 at the beginning of 1897. The combined daily capacity of these factories is 37,200 tons of beets, as compared with 3,750. The combined capacity for a campaign of 88.2 days is 3,281,040 tons of beets, as compared with 330,750 in 1897. The number of factories has increased sevenfold, while the capacity has increased tenfold. The daily output of sugar of these factories is 3,720 tons, as

compared with 426 in 1897. The combined output of sugar for all the factories for the campaign is 328,104 tons, as compared with 37,573 in 1897. The value of this sugar at 5 cents a pound is $32,810,400, as compared with $3,757,300. The average daily capacity of these factories is 664 tons of beets, as compared with 469. The investment in these factories represents a valuation of $36,520,000, and a further investment of $18,260,000 of annual working capital to operate them, as compared with $4,248,000 and $2,124,000, the corresponding amounts for 1897.

This comparison of the status of the industry in 1897 and 1903 shows the progress brought about in six years.

Basing an estimate on the actual results obtained in our factories in 1901, our present factories would employ in common laborers to operate them 13,022 hands. To grow the beets for the factories would require 65,621 laborers on the farms. If we were to produce all the sugar we now consume in the United States, it would require the employment in our factories of 127,167 hands and on our farms for growing the beets 622,165 hands.

REVIEW OF THE BEET-SUGAR INDUSTRY BY STATES.

The following table shows the States in which beet sugar is produced, the number of factories which will be in operation in each State in 1903 with their agregate capacity, and an estimate of their annual sugar product:

Number of factories, with their capacity for working beets and producing sugar for 1903 by States.

State.	Number of factories.	Daily capacity in beets.	Annual capacity for production of sugar.
		Tons.	*Tons.*
Michigan	21	13,100	115,542
California	8	10,200	89,964
Colorado	9	6,250	55,125
Utah	a7	3,350	29,547
Nebraska	3	1,200	10,584
New York	2	1,200	10,584
Wisconsin	1	500	4,410
Minnesota	1	350	3,087
Ohio	1	350	3,087
Oregon	1	350	3,087
Washington	1	350	3,087
Total	55	37,200	328,104

a Three of these are slicing stations only.

MICHIGAN.

The State of Michigan manufactured her first beet sugar in 1898 at Bay City, and the following year 7 factories were located at Bay City (Pl. IV), Rochester, Caro, Kalamazoo, Holland, Benton Harbor, and Marine City; the next year, 1900, a factory was located at Alma; in 1901

factories were established at Saginaw, Lansing, and Salzburg; in 1902, at Sebewaing, Carrollton, Mount Clements, and Croswell; in 1903 factories will be put in operation at Charlevoix, Mount Pleasant, Owosso, Menominee, and East Tawas. To this State the sugar industry has come as a natural sequence of events in her industrial development. The business of the State had been founded largely on lumber production. This has overshadowed her farming interests, which were somewhat backward, considering the great agricultural resources of the State. When her forests were practically cleared, it became evident that the great lumber mills must shut down and other business interests must suffer in consequence. Naturally the people of the State turned their attention to their soil resources. When it became evident that conditions were favorable for sugar-beet production, all of the business interests naturally encouraged the establishment of factories. The State had the capital and organization of the lumber interests just retiring from lumber production. Under these circumstances a rapid development of the industry took place.

Sugar production has been confined to the lower peninsula until recently it invaded the upper peninsula, where there is a number of places whose conditions have been examined and where indications point to the establishment of sugar factories in the near future.

Five years ago all the sugar consumed in the State was produced outside her borders. At the present writing her factories are capable of producing annually 115,542 tons of sugar.

While it can not be said that the State has the best of soil for the production of sugar beets, yet the beets grown there are of a quality and purity acceptable to the sugar factories, and the net profits to the farmer compare very favorably with those from any of the other crops. Unfortunately the seasons have been erratic in the State of Michigan since the production of sugar began. Considered alone, the results of beet growing have been a little discouraging; but in comparison with other crops, the results appear very favorable. From a commercial standpoint, the geographical location of the State is very advantageous. The shipping facilities are probably better than those of any other State in the Union. Nearly surrounded by the waters of Lake Michigan and Huron, it has the advantages of easy and cheap water transportation. It is crossed by a network of railroads which reach the great shipping and commercial centers, such as Chicago, Detroit, and Buffalo. These are advantages that could not be permanently overlooked, so long as the State had an interest not fully developed. While engaged in lumber production, the natural energies of the State were absorbed in carrying out this enterprise. It called for considerable capital. The State's experience in lumber production was comparatively short, but profitable, and it monopolized attention. The State is just as favorably situated for

carrying out successfully any other manufacturing enterprise adapted to its natural conditions. Beet-sugar production, which fosters creameries and other enterprises, came as a favorable substitute for the waning lumber industry. The building of new beet-sugar factories at many points in the State is now proposed, and it appears quite probable that many of them will be constructed in the near future. It is evident that the State will soon not only produce enough sugar to supply its own wants, but will be sending a considerable amount to other markets.

CALIFORNIA.

This State has from the first led in the production of beet sugar. There are reasons why the people of California should have early engaged in the beet-sugar production, though not the same as those influencing the people of Michigan. Among the agricultural interests of the State the greatest development has been in the growing of small grain and fruits. Until quite recently irrigation had not been extensively employed, the farmers depending mostly on the natural supply of water. There are three classes of lands known to the farmers of the State—arid lands, damp lands, and lands under irrigation ditches. The fruit interests of southern California were confined largely to the last of these; on the damp lands were grown small grains. These lands were capable of retaining moisture sufficient to develop crops of small grain after a good supply of winter rain. They were called damp lands because of their peculiar capability of holding moisture, which probably came from the subirrigation or drainage of the water from higher levels. The dry lands were higher up and not nearly so valuable. It became evident to the farmers that they could not continually grow small grains; alfalfa was therefore introduced in rotation with other crops and was found very helpful in many ways, especially as a soil renovator, and sugar beets were tried with success.

Some years ago the State had a period of depression from which it has recovered. It was far removed from the Eastern markets, reaching them only by a long circuitous trip by the sea requiring several months, or overland by railroad requiring fifteen to twenty days or more. Many of the fruits grown in California are too perishable for long shipment. This necessitates preparation of the fruit by canning and preserving in different ways. California had a great many competitors in this prepared-fruit production, some of them much more favorably situated as regards the Eastern markets. Fruit production was not meeting expectations; it was overdone. Shipping the perishable fruits was more or less hazardous, and the canned fruits came into such severe competition with those more favorably situated that the growing of these fruits became somewhat discouraging. Sugar beets came to the State as a natural crop, serving to relieve the difficult

situation of both the grain raisers and the fruit growers. Since the introduction of sugar-beet growing, there has been a general improvement in agricultural methods and results, and a better understanding of the conditions of the State. Farmers have learned to plant earlier and take longer advantage of the winter rains. They have also discovered water resources which can be made available for irrigation through artesian wells, many of these flowing. While the beet-sugar industry has rapidly increased in importance, fruit growing has not lost its popularity as one of the leading industries of the State.

Many new beet-sugar projects are under contemplation in California, some of them having a capitalization of several million dollars, and including the building of irrigating ditches, along which are to be established at various places several factories, the ditch contributing water to lands for growing sugar beets for all of them.

California will probably always maintain a leading position among the States in the production of sugar beets as it does in other lines of industry. The building of an isthmian canal will probably give this State especial advantages that will greatly promote its progress.

COLORADO.

We are inclined to think of Colorado as a mining State, and in comparison with others she is fully entitled to be classed as such. It seems incredible to some people that the value of Colorado's agricultural interests is greater than that of her mining interests, and further that they are annually outstripping in growth her mining interests. Outside of grazing Colorado would not cut much figure in an agricultural way if the irrigating ditches were left out of consideration. It is through irrigation that the State is coming rapidly into prominence in the production of roots, cereals, and forage crops. Her soils are hardly excelled when sufficient water is placed on them.

The State experiment station in 1896 began extensive experiments in growing sugar beets in all parts of the State. These experiments, like those in many other parts of the United States, were conducted under very unfavorable circumstances. In order to test the different soils and sections of the State, the experiments were dependent upon farmers who had had no experience in growing sugar beets. Many of them were newcomers unacquainted with the proper methods of growing any kind of crop under Colorado's conditions. However, results of these experiments always indicated that conditions in the State were favorable to the production of sugar beets. A factory was built at Grand Junction in 1898. Another large factory was built in the same year at Rockyford. This place had attained considerable prominence in the commercial world by furnishing the famous "Rockyford" melons, of superior sweetness and flavor. It was assumed that a soil and climate which could accomplish such results with melons ought to

be very favorable for producing sugar beets. Experiments indicated this to be true. This factory was a great success from the beginning. Another one followed, 17 miles distant, at Sugar City, the same year; another at Loveland in 1901, and still another later. There are now 9 factories in the State. All of them have shown very high results in tonnage per acre. In sugar content of the beets, no other beet-producing area has ever excelled Colorado, year after year, the beets worked at some of the factories having an average sugar content of over 17 per cent. This average is far beyond the highest expectations of scientists when they began the breeding of sugar beets for a higher content of sugar.

There are a great many projects contemplated for utilizing other fertile valleys or parts of valleys in Colorado. Agriculture in this State was, prior to 1897, practically confined to grazing, alfalfa, potatoes, and small grains. It has extensive natural irrigation resources to draw on for further development. The great Rocky Mountain chain passes through this State. It is traversed by several streams, carrying the waters of the melting snows of winter and the rains of spring seeking outlet to the sea. Under the new irrigation laws this water will eventually be stored and held to supply the many fertile valleys of Colorado with sufficient water to produce abundant crops. The leading feature will be sugar-beet growing. The natural resources of soil and water supply will give to Colorado an advantageous position in the production of sugar beets. If any argument were needed to establish the feasibility of storing water, such as is contemplated by the new irrigation law, one needs only to mount the foothills or mountains north of Denver and cast his eye to the east over that broad expanse of fertile valleys. He will see hundreds of tiny lakes glimmering in the sunshine, awaiting only the opportunity when needed to enliven the activity of the soils throughout the valleys, producing those abundant crops for which the section is noted. These lakes are artificial, having been placed on these higher grounds by combinations of farmers or companies for the purpose of developing these beautiful valleys. They are crude attempts as compared with those contemplated by the Government under its new irrigation law. There is much waste in connection with them, but they have been resourceful in accomplishing the work of the designers. Reservoirs bounded by the rocky walls of the mountains will be much more permanent and efficient for storing these waters; a more comprehensive plan, under the direction of better engineers, will probably be a great deal more effective. But these hundreds of artificial lakes are conclusive evidence of the utility of storing water.

I must call attention to another thing favorable to manufacturing in Colorado. The mountain streams afford great opportunities for power. The same is true of Utah, Idaho, and other States of the

mountain region. This power can be transformed into electricity, which can be harnessed to the work of moving the wheels of machinery. This is actually taking place in Utah. The power producing electric lights of towns, used in operating street railways, in mining, and, to some extent, in the sugar factories is contributed by the rush of waters down the mountain sides. Such natural facilities aid much in cheapening the cost of production. They are the free contributions of nature which will continue for all time.

UTAH.

This was the third State to enter the field as a producer of beet sugar, the first factory being built at Lehi City in 1891. In this State again we find the introduction of this industry influenced by strong circumstantial causes. The farms in Utah are small, usually ranging from 10 to 40 acres. The farmers of Utah had gone further in the development and use of irrigation than in other parts of the United States. These small farms had been made as productive as possible, and afforded employment for a maximum amount of labor. Such conditions are ideal for sugar production. It is never advisable in starting the growing of sugar beets for a factory to encourage the farmers to put in more than 5 to 10 acres each; and, in fact, with most farmers who have acquired experience, it is never advisable to encourage a much larger planting than 10 to 20 acres. Some farmers are capable of handling a much larger field than this, but as a rule it is not advisable. There is no general field crop that requires so much outlay for labor as sugar beets, but there is probably no other crop that will meet the expense and return a good profit in addition so readily.

The people of Utah had been accustomed to supplying their own needs as nearly as possible by their own efforts; sugar was an item of importance in their daily wants. The production of sugar beets and the manufacture of sugar fitted so nicely into their system of farming and industrial life that it came as a matter of course as soon as the industry began to attract attention in the United States. That the wisdom of introducing it into Utah has been fully demonstrated is shown by the fact that this first factory has been able to produce it more cheaply than any other factory in the United States. The results of this first factory gave sugar manufacturing an impetus in Utah, and now they have, counting three rasping stations connected with the Lehi City plant, seven factories, with a combined daily capacity of 3,350 tons of beets and a practical estimate of annual output of sugar of 29,547 tons. The present annual consumption of Utah is 9,464.8 tons of sugar. Her production surpassed her consumption some time ago, and now the State is shipping over 20,000 tons of sugar to Missouri River points and other markets.

There are quite a number of projects under consideration in Utah,

having in view the utilization of large tracts of land in fertile valleys where additional water for irrigation purposes can be had. These lands are well located for utilizing water power, securing shipping facilities, and developing feeding and dairying. Utah is sure to continue, as it has started, one of the leading sugar-producing States of the Union.

NEBRASKA.

It will be noticed that in the case of the last three States, California, Colorado, and Utah, irrigation plays a leading part in the industry. The results in Michigan and Nebraska, where beets are grown under rain conditions, are offered in comparison. The mountain and coast States have some favorable conditions which Michigan has not, especially in the high sugar content of the beets grown there; but Michigan has some advantages in her location, markets and shipping facilities which the Western States have not.

Nebraska was the second State to enter the field of beet-sugar production, establishing a factory at Grand Island in 1890. This factory is about midway between the two extremes of rain conditions in Nebraska, the eastern portion securing sufficient rain for cropping, and the western portion being too arid for this purpose, but suitable for grazing. There are many things in the northeast quarter of the State that give to beet-sugar production ideal conditions, among which may be mentioned nearness of the stock range and facilities for feeding and shipping stock. The soil is generally a sandy loam, and seems adapted very well to production of sugar beets, corn, oats, and all kinds of forage.

There are three beet-sugar factories in the State, having an aggregate capacity for working 1,200 tons of beets daily and manufacturing 10,584 tons of sugar annually, the present annual consumption of sugar in the State being 36,467.5 tons. While there are other projects contemplated in Nebraska, some of which will probably materialize into beet-sugar producing concerns, yet I take it that sugar production in the State will not become an industry of predominating importance.

NEW YORK.

The situation in beet-sugar production in New York State is rather anomalous. Practical experience in manufacturing sugar has not entirely confirmed the results of experiments. In many places the soil and natural conditions for cropping are quite favorable to beet production. The transportation facilities can hardly be surpassed, even by those of Michigan. So far as its markets are concerned, it is probably more advantageously situated than any other State. The farmers are thoroughly accustomed to garden crops, dairying, and the uses of by-products of all kinds in their food rations. Yet it can not

PILE OF BEETS BY RAILROAD TRACK TOGETHER WITH FORCE EMPLOYED HANDLING BEETS. MINNESOTA SUGAR COMPANY, ST. LOUIS

be said that the results so far in New York in producing beet sugar are the most flattering. To me they have been quite disappointing. I had occasion to spend some time in New York during last fall about the time beets were harvested for the sugar factories and, in talking with the farmers in many sections where they are growing sugar beets, I found that the most reasonable explanation which could be given is the fact that sugar beets have to compete with too many other well-established crops in which the farmers are well posted and to which they are wedded to such an extent that they hesitate to give them up. There is a tendency among the farmers of New York to grow certain special field crops, differing from those grown on the cheaper lands farther west, with which they do not have to come into competition. I found one locality almost entirely devoted to peppermint, another one to broom corn, another to cabbage, etc. Farmers are receiving substantial returns from these crops and are satisfied to continue with them rather than take up others requiring more expense and labor in cultivation, such as sugar beets, even though remunerative in the end. Hence the factories in New York have not achieved great success, simply because, up to date, they have not been able to interest the farmers in growing sugar beets. There is no question but that the prospects are improving in this respect, and that the day is coming when sugar beets will receive a larger share of attention. Eastern farmers find some difficulty in selecting the field crops which will enable them to avoid Western competition. This competition has been felt so strongly and keenly that they hesitate to take up something new. There is no question but that it is a great deal harder in the State of New York to procure acreage for a beet-sugar factory than in any other part of the country. There are some projects being talked of for the future, and no doubt, while the State will be slower to take up the industry than some of the States farther west, in time it will show substantial interests in beet-sugar production.

WISCONSIN.

Attention has elsewhere been called to the fact that in 1869 a factory was established at Fond du Lac. It was of small capacity, but its equipment was up to date. The project was hampered for want of funds. I mention this factory here because, of all the contemporaneous attempts to manufacture beet sugar in the United States, this was the only one that gave evidence of success. It was not appreciated there at the time. The people managing this concern through superior inducements inspired by their work, were persuaded to go to California, not receiving sufficient encouragement to stay where they were. This was unfortunate. There is no telling what Wisconsin might be doing in beet-sugar production to-day had these people continued in their successful career at Fond du Lac. As it was they

went to California and failed. If they had stayed they would probably have succeeded and the industry in the United States would have received an earlier start and Wisconsin would have enjoyed its benefits.

Another attempt was made about five years ago at Menominee Falls. This failed for want of proper construction of machinery. The factory went into the hands of a receiver, lay idle for three years, and was finally bought up by a new company, reequipped with modern machinery, and is now a very successful enterprise. It is situated in a locality that has always shown good results in sugar-beet growing, both in the experiments of the State Experiment Station and in growing beets for both the old and the new factories.

Although Wisconsin has been unfortunate in the two failures mentioned at different periods, which have produced more or less discouragement, yet this State must be regarded as one that will eventually rank high in beet-sugar production. It has facilities for shipping and markets quite similar to those of Michigan; it is highly developed agriculturally; it ranks as one of the leading States in creamery production; it has a suitable soil, much of it higher and better drained than that of Michigan. It is available for inspection and exploiting by capitalists; it is experienced in manufacturing, and it has a farming element ambitious and progressive in agricultural development. There are no less than a half dozen projects contemplated that are likely to materialize as beet-sugar producing concerns no later than 1904.

MINNESOTA.

This State has one factory at St. Louis Park, near Minneapolis (Pl. V). This factory has worked the beets of four successive crops. At first it had difficulty in getting sufficient acreage to produce the required amount of beets. Farmers were accustomed to growing wheat, oats, corn, potatoes, and flax, and were not inclined to abandon these for a new crop. Sugar beets compared so favorably during the last two years, both under conditions of extreme drought and extreme wet, that the factory was enabled to overcome this obstacle, and had for 1902 about 32,000 tons of beets, giving it a fairly successful campaign. Farming is quite diversified in the southern portions of the State, and there are many localities well adapted to the cultivation of sugar beets and the production of sugar. The State is already experienced in manufacturing, being the leading flour-producing State of the Union. With its splendid facilities for growing sugar beets, natural conditions of soil and climate, shipping and marketing facilities, and a general tendency favorable to beet-sugar production, it must be reckoned as a State that will show considerable beet-sugar production in the future.

A few years ago the legislature of Minnesota enacted a bounty law to encourage the production of beet sugar in that State. In 1898 and 1899, under this law, bounties were paid to the Minnesota Sugar Com-

pany, whose factory is at St. Louis Park, near Minneapolis. In 1900 this company claimed as bounty $19,923.56 on its product of 1,992,356 pounds of sugar, but the payment was then refused on the ground that the act was unconstitutional. This led the sugar company to prepare a report of its operations, which it laid before the State legislature the past winter (1902–3).

As this report contains much information that is valuable to those interested in the beet-sugar industry, I introduce here a number of extracts from it:

The sugar content of Minnesota beets has been raised from 10½ per cent in 1898 to 15 per cent in 1902. The farmers have demonstrated for themselves that beet raising is more profitable than most other crops, receiving, as they did last year from the Minnesota Sugar Company, net returns, after deducting freight charges and cost of seed, ranging from $47.25 to $101 per acre for their crop, as shown by the figures given in this statement.

The Minnesota Sugar Company, during the year 1902, consumed about 64,000,000 pounds of sugar beets, which it received from 2,000 farmers, residing in 43 different counties of the State, paid therefor the sum of $157,241, and manufactured therefrom 8,706,372 pounds of pure white granulated sugar.

This company, during the five years it has operated its factory, has purchased from the farmers of Minnesota 222,644,024 pounds of sugar beets, paying for the same the sum of $522,694.50, and has manufactured therefrom 24,223,360 pounds of chemically pure white sugar. It has paid to the transportation companies in the way of freight $175,000, on which the State of Minnesota has received under the gross earnings tax the sum of $5,250.12. It has paid for supplies and materials consumed in the manufacturing process $250,000, and employs 300 men, to whom is paid in wages $700 per day.

This pioneer company has not only demonstrated the superiority of the soil and climate of Minnesota for growing sugar beets, but has opened up the way for a successful and profitable prosecution of the industry in all parts of the State.

SUGAR-BEET PRODUCTION AND FACTORY RESULTS.

The following table has been prepared to show the development which the agricultural side of the beet-sugar industry has attained in Minnesota. More than 2,000 farmers supplied beets for the factory in 1902; these are located in 43 counties, and the list of producing counties is increasing every year. In the table are given the principal shipping stations from which beets were received in 1902, the acreage at each of these shipping points, the quantity of beets shipped, and the amount received for them by the farmers:

Statistics of sugar-beet production in Minnesota for 1902.

Shipping station.	Number of acres in beets.	Number of carloads shipped.	Net amount of beets received at factory.	Amounts paid to farmers.	Local expenses for weighing and supervision.
			Pounds.		
Annandale	50½	17	801,174	$1,976.04	$102.05
Arlington	46	28	1,274,175	3,108.04	107.80
Augusta	10½	6	193,820	472.27	5.00
Belleplaine	26½	12	462,505	1,159.10	54.42
Bixby	11	7	183,070	461.78	5.00
Bongards	34½	20	831,425	2,031.48	99.02
Buffalo	23	11	421,445	1,027.60	25.00
Carver and Dahlgren	35½	18	769,783	1,878.35	50.70
Chanhassen	7½	4	174,795	425.92	9.00
Chaska	22½	13	590,590	1,440.90	25.00
Cokato	135½	47	2,435,395	5,938.50	198.97

Statistics of sugar-beet production in Minnesota for 1902—Continued.

Shipping station.	Number of acres in beets.	Number of carloads shipped.	Net amount of beets received at factory.	Amounts paid to farmers.	Local expenses for weighing and supervision.
			Pounds.		
Cologne	9¼	5	241,015	$587.11	$10.00
Dassel	244¼	121	5,444,440	13,287.58	601.26
Delano	17	8	291,770	711.37	20.93
Dodge Center	28¼	7	207,130	523.42	10.00
East Henderson	20	8	384,130	936.76	30.00
Eden Valley	47	12	563,869	1,374.39	47.48
Elk (Newmarket)	12	9	226,625	553.03	18.10
Empire and Vermillion	21	8	364,635	889.74	10.00
Faribault	19¼	11	427,755	898.12	20.00
Forestlake	38	16	716,377	1,476.74	27.50
Gaylord	45	21	959,646	2,457.81	37.60
Glencoe	40¼	24	942,645	2,298.95	78.00
Hamburg	25½	18	785,245	1,916.74	86.00
Hamel	12	7	276,980	674.75	11.00
Hastings	107¼	57	1,956,980	4,498.24	119.95
Jordan	61¼	29	1,282,275	3,127.60	74.10
Kilkenny	30	12	479,705	1,170.65	21.85
Kimball	52¼	18	682,033	1,662.64	45.00
Lesueur	23	12	457,245	1,114.01	20.00
Lesueur Center	37	18	756,820	1,995.89	90.00
Litchfield	20	7	278,495	679.12	16.00
Mankato	40	19	691,380	1,700.00	11.00
Mapleplain	24	10	406,078	990.97	4.85
Mayer	18	10	405,330	989.33	20.00
Medford and Owatonna	53¼	33	1,113,885	2,720.73	18.20
Mendota, Westcott, Nichols, Rosemount, and St. Paul	49	31	1,129,665	2,757.17	117.60
Montgomery	162	98	4,812,030	11,776.64	396.71
Morristown	13½	6	258,435	576.72	9.10
Morton	26¼	10	397,829	1,008.44	23.00
Mulfords	27¼	13	519,570	1,267.81	14.25
New Prague and Heidelberg	260¼	115	5,159,875	12,618.16	605.91
Nelson	47	27	971,700	2,445.15	64.89
Nerstrand	10	5	153,035	373.86	12.60
Northfield	16	9	289,620	708.37	16.75
Olivia	21¼	17	551,095	1,345.30	60.50
Otisco	21	5	256,725	628.45	4.50
Pennock	64	15	426,000	975.00	15.00
Plato	16¼	10	377,635	921.51	30.00
Racine and Stewartville	29	11	380,020	959.57	15.00
Rich Valley	16	6	214,300	523.14	10.00
Robbinsdale	15	5	174,540	435.63	10.00
St. Bonifacius	9	5	182,745	446.25	10.00
St. Michaels	20¼	8	253,650	618.30	10.00
Smithlake	18	8	354,125	862.93	5.00
South Haven	44	18	544,254	1,328.84	33.00
Vesely	8	4	107,270	271.52	.....
Victoria	7	4	138,160	336.79	5.00
Waconia	62½	33	1,466,350	3,698.05	119.58
Waterville	26¼	14	428,335	1,048.19	21.70
Winthrop	22	11	463,939	1,164.19	31.50
Withrow	26	9	420,390	1,025.30	37.95
Young America	14¼	7	404,560	986.71	14.05

In the following table are summarized the principal facts in connection with the operations of the factory for five years:

Statistics of factory operations for the five years 1898–1902.

Year.	Amount of beets received from farmers.	Number[a] of farmers receiving pay for beets.	Amount paid to farmers for beets.	Amount of chemically pure sugar made.	Wages[a] paid to agricultural employees.[b]
	Pounds.			*Pounds.*	
1898	[a]22,000,000	900	$46,413.54	1,994,700	$21,000
1899	42,871,080	1,500	99,414.59	4,581,463	23,000
1900[c]	39,126,124	1,400	92,646.69	2,715,000	25,000
1901	54,646,820	1,800	126,978.67	5,225,825	36,000
1902	[a]64,000,000	2,000	157,241.01	8,706,372	23,000

[a] In round numbers.

[b] This comprises the wages paid by the Minnesota Sugar Co. to field laborers and general farm help, and to instructors and overseers in the agricultural branch of the factory's operations.

[c] A bad year for all kinds of crops on account of continuous drought.

The Minnesota Sugar Company pays for beets $4.50 per ton, and pays 35 cents per ton on freight charges, making the cost of beets delivered at the factory $4.85.

It employs 300 men in its factory, day and night shifts, and its salary and pay roll amounts to about $700 per day. It furnished employment during the winter in the factory to a large number of farm hands, who cultivated the beet fields in the summer.

For supplies and material consumed in the manufacturing process the company paid, during 1901, $54,000, and during 1902, $66,000. It also paid in freight charges to the railroad companies of Minnesota during 1901, $35,000, and during 1902, $52,000.

Minnesota's soil and climate are admirably adapted to the production of sugar beets. Beets from this State took first prize at the Pan-American Exposition at Buffalo.

RESULTS SECURED BY SOME MINNESOTA FARMERS.

In the following table are compiled some figures showing the actual results secured by some of the most successful farmers growing sugar beets in Minnesota in 1901:

Some of the best results secured by sugar-beet growers in 1901.

Name and post-office of grower.	Number of acres planted in beets.	Growers' gross returns.	Growers' net returns.
Theodore Arens, Jordan	26	$1,842.15	$1,519.39
John Boo, Dassel	5	386.63	304.98
John Mathews, Plato	2	156.94	184.03
Wm. Huhs and Ed. Grimm, Waconia	a 40	2,439.29	2,065.19
Fred Buck, Hamburg	a 10	582.40	472.67
Fritz Bohnsack, New Prague	2	170.95	142.20
John Brezino, New Prague	2	203.11	167.65
John J. Dietz, Montgomery	2	144.28	117.96
M. M. Powell, Montgomery	9	546.85	442.03
Wm. Trapp, Mendota	2	147.36	124.62
Aug. Nachtigall, Westcott	3	160.58	131.14
John Lonien, Faribault	2	207.64	165.62
Louis Englund, Nelson	2	135.84	99.45
Wencel Hermann, Heidelberg	1	95.62	86.46
Johann Martin, Owatonna	1	80.26	70.14
Wm. Luehring, Hamburg	3	359.27	321.50
O. E. Stromberg, Buffalo	2	158.33	139.14
Geo. Dimler, Chanhassen	2	195.49	183.14

a About.

OPINIONS OF MINNESOTA FARMERS.

The opinions and acknowledgments of beet growers themselves are valuable as showing what the farmers think of this industry. The following are extracts of letters received from beet growers:

John Boo, Dassel, Minn.: I raised sugar beets on 6 acres, for which I received $50 an acre. That is better than to raise wheat.

Henry Arens, Jordan, Minn.: I planted 26 acres of sugar beets this spring. I have now received $1,519.39 from the factory for same. That is about $58 an acre. I am more than satisfied with beet raising. I shall raise 36 acres next year.

C. N. Cosgrove, Le Sueur, Minn.: I raised 35 acres of sugar beets last year. I am very well satisfied with the results. Every farmer who has suitable land should engage in beet raising.

William Huhs, Waconia, Minn.: I planted 50 acres of sugar beets this spring. The result is very satisfactory to me. I would advise all who have good land to plant sugar beets.

A. J. Broberg, Dassel, Minn.: I planted last year about 2½ acres of sugar beets. I have contracted for 10 acres for next year. I find that the cultivation of sugar beets is paying, particularly for a farmer who has a small place, because I can make just as much money from 10 acres planted to beets as a farmer can from 40 acres to wheat.

Aug. Johnson, Becker, Minn.: I received check the other day for beets raised on 15 acres of my farm at Becker. The distance from Becker to the factory is 50 miles. I netted about $40 to the acre. I am perfectly satisfied with the returns. I believe beet raising is a paying proposition, provided you attend to the beets. Farmers will say that there is a great deal of work connected with beet raising. Yes, there is a great deal of work connected with beet raising if you don't understand how to take care of them; but if you do the question of work will never bother you. I raised 15 acres last year and I shall raise 20 acres the coming year.

Mr. Fred Windmiller, Mankato, Minn.: In spite of unfavorable weather conditions and the comparatively high freight rate of $1 per ton last year, we cleared $25 net on each acre devoted to sugar beets on rented land with all help hired.

Charles Rihter, Montgomery, Minn.: Your checks at hand and all my farmers are well satisfied with your treatment. I can assure you 300 acres for 1903 at Montgomery. Some of my farmers are anxious to go into it to a large extent, from 6 to 20 acres each, but I would rather see smaller acreages and lots of tons of beets. With the results and treatment they are receiving they can be well satisfied. I am sure that every farmer who had beets planted in 1902 will contract again for one or two acres more than last year and lots of new farmers have asked for seed already. Send me a supply of contracts, instructions, etc.

Mathias Nohava, Wheatland, Minn.: The prospects for beet growing for 1903 will be very good. The farmers around this territory are very well pleased with raising beets. If we get a side track at Wheatland we will guarantee 500 acres of sugar beets.

Julius Radzam, Waconia, Minn.: Mr. Winkler, who planted 2 acres this year, received the money already for his beets and is very much pleased with it. He told me to put him down for 10 acres for next year. He has his land prepared. All the farmers who received their checks are well pleased and will double their acreage next year.

Jos. Hovorka, New Prague, Minn.: We have finished shipping from here and Suchomel Crossing, having loaded in all 113 full carloads, as against last year's 68, an increase over last year of 45 carloads. The people at Suchomel Crossing had a meeting last Sunday and then and there pledged themselves to plant at least 125 acres to beets next year. Here in the New Prague district there will be at least 300 acres planted for 1903. It is with great pleasure that I reassure you that all farmers are well satisfied. Certainly the sugar-beet industry has passed successfully its experimental stage and has come to be a great blessing to our small farms.

D. S. Todd, Hutchinson, Minn.: Your letter and check were received to-day. I am well pleased with the amount you sent. Am satisfied that there is money in raising sugar beets.

O. E. Stromberg, Buffalo, Minn.: I have shipped in all 74,860 pounds, or nearly 37½ tons, of beets. I consider this a good crop of beets from 2 acres, being nearly 19 tons per acre. My check for beets this year will be very much appreciated, as the sugar beet is the only product that will bring me any cash this year; all my other crops were destroyed by hail. Sugar beets are a sure and profitable crop to grow as hail and storms have no bad effect on them.

Frank Wickenhauser, jr., Cologne, Minn.: I will plant 2 acres next year, for I am very much pleased with last year's results. I could not have done as well with any other crop, for my single acre of beets yielded me more net than 9 acres of wheat, and I call that very good, and worth being recommended to others.

OHIO.

This State has a factory at Fremont. As in New York, it has been difficult to turn the farmers from their natural trend in producing special crops. There are in Ohio many places having conditions favorable to beet-sugar production. The farms are small and the soils are resourceful; the State has an abundance of fuel, splendid markets, cheap shipping, manufacturing experience, dense population, and stock-raising and dairying interests. There has been more or less talk about

establishing other factories, but none of them seem likely to materialize in the near future. I hardly think that the interest taken in the State has been commensurate with its natural advantages.

OREGON.

Oregon was one of the States originally conducting extensive experiments in growing sugar beets under the direction of Professor Shaw of the State experiment station. It was demonstrated at that time that there were many localities adapted to the successful introduction of this industry. A factory was established at La Grande in 1898, and, while this portion of the State had shown the best results under the experiments, the particular place selected for the factory was probably not the best, since the factory has been unable to interest the farmers in its vicinity to any considerable degree in production of sugar beets, but has been compelled to go to a valley at some distance from the factory to have its beets grown, and almost the entire supply of beets for the factory are brought in by cars. This factory is gradually overcoming its difficulties. I think there are many other places in the State where the sugar-beet industry might be introduced with advantage.

WASHINGTON.

This State was early exploited under the direction of the State experiment station in numerous experiments covering several years. A factory was established at Waverly, near Spokane. One of the difficulties in Washington has been the fact that the agricultural interests in the State are practically new. Agriculture consists largely in the production of small grains, for which the State has superior advantages. For this reason the factory at Waverly has found it difficult to secure sufficient acreage. However, Mr. Corbin, the owner, has been ceaseless in his energies and not lacking in faith in the outcome of the enterprise. Each year it is gradually working into better shape, and its future success appears to be established.

There is considerable interest in a proposition for establishing a factory southwest of Spokane, in what is known as the Yakima Valley. This is a large valley, very fertile, and especially resourceful in wheat growing. There are many reasons why it is favorable to the production of sugar beets. The next two or three years will probably see two or three more factories in the State of Washington.

REVIEW OF CONDITIONS AND PROSPECTS FOR NEW FACTORIES.

There is a prospect that many new beet-sugar factories will be installed during 1903. Most of these will be in States which already have one or more factories, but there is considerable possibility that the industry will invade some new fields.

ARIZONA.

It has been shown by extensive State and private experiments that there are several places in the State adapted to sugar-beet production. A company has organized and capitalized for building a beet-sugar factory of 1,000 tons daily capacity near Phoenix. This company appears determined to execute its plans. Last year it was arranged to build a factory which should be in operation for 1902, but it was deferred, and now it is intended to have the factory in operation for 1903. It is proposed to grow beets entirely by irrigation.

CALIFORNIA.

There are prospects for the construction of new factories at several points in California, among which the following may be mentioned:

ANTELOPE VALLEY.—The vice-president of the Antelope Valley Improvement Company reports that this company has already contracted for the construction of a factory and the building of the machinery. The factory, a 1,000-ton plant, will be built and in operation in the valley for 1903.

MARYSVILLE.—It is announced that arrangements have been made for building a sugar factory in Tehama County, between Tehama and Corning, and that a contract for the building of the same will soon be made. It is claimed that the power for the factory will be electricity, the same power being used in pumping water for irrigation. The factory is to be of 500 tons daily capacity.

MODESTO.—Another factory, of 600 tons daily capacity, is proposed for Modesto. It is a part of the plan of this company to locate a colony of Dunkards on the lands on which the beets are to be grown.

COLORADO.

The success of the factories already in operation has naturally resulted in the formation of many plans for the installation of new factories. The following are places at which there are good prospects for the construction of factories:

ALAMOSA.—For several years the farmers around Alamosa have been growing beets for sugar factories and testing local conditions. Several times agitation has almost culminated in the location of a factory at this place. Now it is announced that a company has been organized, capital has been subscribed, and a 600-ton factory will be constructed in this place in time for the campaign of 1903. The Southern Colorado Land Company has agreed to plant 4,000 acres of beets for the factory. A colony of Russians is being brought in from Kansas and other places to assist in growing the beets. It is the purpose of this company, it is claimed, to establish pipe lines similar to those at Lehi City, Utah, so

that juice can be pumped from slicing stations located in different parts of the county.

BRIGHTON.—Plans have been arranged to build at Brighton a 500-ton beet-sugar factory, and contracts are now being arranged with the farmers to grow sufficient beets to operate this factory for 1903. The promoters have secured up to date about two-thirds of the required acreage.

BRUSH.—It is announced by the Denver Times that the contract has been closed for the erection of a 1,200-ton factory at Brush, to be in operation for 1903, the chamber of commerce agreeing to furnish contracts for 5,000 acres of beets.

ARAPAHOE COUNTY.—It is the plan of the Denver Sugar and Land Irrigation Company to build a factory of 600 tons daily capacity in Arapahoe County, to be in operation for 1903. The company has purchased outright about 8,000 acres and controls in all 17,000 acres. The plan contemplates the rebuilding of the Castlewood Dam and the irrigation of the lands by this means.

FORT COLLINS.—A factory of 600 tons capacity is now building at Fort Collins, having five-year contracts covering 7,000 acres of beets. This factory is located at the home of the State agricultural college and experiment station, which did such effective pioneer work in paving the way for the establishment of the beet-sugar industry.

FORT LUPTON.—There is considerable talk of building a 600-ton beet-sugar factory at this place. Plans are immature, but the project must be classed among the possibilities.

FORT MORGAN.—I have advices from Colorado that contracts have been let for building a factory of 1,200 tons daily capacity at Fort Morgan. Contracts have been made with farmers to grow 5,000 acres of beets. The valley in the neighborhood of this place is irrigated by the Bijou Canal.

LAMAR.—There has been considerable talk for the last two or three years of establishing a beet-sugar factory at Lamar. Beets have been grown in this vicinity and always show good results. Recently an enthusiastic meeting was held here and 5,000 acres of land were pledged for growing sugar beets for five years under the guaranty of the Commercial Club. A committee was appointed and is now negotiating with capitalists to carry out this project. In view of the favorable conditions at this place, as shown by a long series of tests and the continued agitation in favor of the industry, this place will probably have a factory of 1,000 tons capacity ready for operation in 1903 or 1904.

LAS ANIMAS.—The farmers and business men of this vicinity have been agitating for some time the establishment of a beet-sugar factory. At a well-attended meeting recently 3,000 acres were pledged, and it

was evident that 8,000 acres could be readily secured if necessary. Negotiations are pending between those locally interested and outside capitalists for the purpose of erecting a 700-ton plant at this place.

La Jara.—At this point considerable talk has been had with reference to establishing a beet-sugar factory. The farmers stand in readiness to grow the beets, business men are negotiating for the establishment of a 1,000-ton factory, and it looks as though such a factory may be constructed in the near future.

Longmont.—I announced in a previous report the interest taken by Longmont business men and farmers in establishing a beet-sugar factory at that place. It has been under consideration for some time by different combinations of capitalists. The efforts finally culminated in the closing of a contract recently for the building of a 600-ton sugar factory to be in operation in 1903. The factory building is to be large enough to double that capacity as soon as desirable, and it is probable that by 1904 it will be increased to a 1,200-ton plant.

Fowler.—At Fowler the farmers have made pledges to grow 5,000 acres of beets for a factory to be established at that place. It is announced by the officers of the Great Western Construction Company that a factory of 1,000 tons daily capacity would soon be established at this point. As securing acreage is the principal difficulty nowadays, and this company has overcome the chief obstacle, the probabilities are that a factory will be in operation here in the near future.

Holly.—The farmers around this place have been growing sugar beets for some time and disposing of them to the factory at Rockyford, but the Arkansas Valley Sugar Beet and Irrigation Company contemplates the establishment of a large beet-sugar factory at this place. Their lands have been disposed of in small lots of 40 acres, each of which has an abundant supply of water. It is quite probable that the factory will soon be built, either by this company or by other parties who have been considering the matter.

Manzanola.—For two years farmers have been growing sugar beets extensively in this section of the country for the factory at Rockyford. Results have been so encouraging that the farmers and business men of the section have organized and are negotiating with capitalists for the establishment of a beet-sugar factory. It is claimed that they have a proposition from a company to build a factory of 1,000 tons daily capacity at this place. A company was also organized in Denver, called the Manzanola Sugar Company, capitalized at $500,000, having in view the establishment of a factory here. Indications point to the building of a factory for 1903 or 1904.

Windsor.—A contract has been let for the building of a 600-ton factory, to be in operation for 1903. Contracts have been secured

with the farmers for sufficient acreage of beets covering a period of years, and the factory is now under construction.

OTHER POINTS.—There has been considerable agitation, with possibilities of success, looking toward the establishment of beet-sugar factories at Mosca, Montevista, and Platteville. There are quite a number of other places at which more or less consideration has been given to the establishment of factories. I have mentioned enough, however, to indicate that the whole State of Colorado is thoroughly alive to beet-sugar production and that it is bound to be one of the leading sugar-producing States.

IDAHO.

In order to encourage beet-sugar production in this State, the legislature recently offered a bounty of 1 cent per pound for the first year of the manufacture. There are several places in Idaho at which the establishment of beet-sugar factories is contemplated, having the conditions of soil, facilities for irrigation, water power, and other natural advantages.

BINGHAM.—Two companies have been testing the resources of the Blackfoot country. A company was organized especially for building a factory here, and, as the Utah Sugar Company had also entered this field, it was finally decided that the two should blend their interests in building a factory of 1,000 tons capacity. This has been decided upon, and a factory will be in operation in 1904, possibly in 1903.

RIGBY.—Some persons interested in the Great Western Sugar Company, of Loveland, Colo., have secured pledges from the farmers and propose building a factory near Rigby, or between that place and Idaho Falls. They propose erecting a factory of 500 tons daily capacity, to be ready for the campaign of 1904.

MOUNTAIN HOME.—The Idaho Beet Sugar Company is planning the erection of a large factory at this place in the near future. Beets are being grown experimentally, and indications are that the project is a strong probability.

UTAH.

BEAR RIVER.—The Utah Sugar Company is constructing in this valley a factory of 1,200 tons daily capacity for the campaign of 1903.

GUNNISON.—It is claimed that capital and acreage have been secured for building a 1,000-ton sugar factory at Gunnison for the campaign of 1903. This place has been quite thoroughly tested in growing sugar beets for several years for the factory at Lehi City.

WASHINGTON.

NORTH YAKIMA.—I have authentic assurance that a company organized at this place has secured capital and acreage and will build a 600-ton sugar factory for the campaign of 1903 or 1904.

EVERETT.—There are strong possibilities that a factory of 600 tons capacity will be constructed at this place in the near future. Capitalists have agreed to put up the plant provided acreage can be secured, of which there is little doubt.

NEW MEXICO.

Undaunted by the failure of the factory at Carlsbad and its final destruction by fire, people in the various sections of New Mexico are seriously considering the establishment of beet-sugar factories. Several valleys that have been pretty thoroughly tested by private enterprise have shown favorable results in beet production. At each of the following places a factory of 500 tons capacity is proposed: Albuquerque, Santa Fe, and Carlsbad.

MONTANA.

Through her State experiment station Montana is conducting investigations and experiments with sugar beets. The conditions and facilities are similar to those of Idaho and Utah. There are many fertile arid valleys in which sugar beets will succeed with irrigation. Several of these have been thoroughly canvassed. There are at least three projects in the State that will probably materialize in the near future.

NEBRASKA.

For some time a portion of the supply of beets for the sugar factory at Grand Island has been coming from the western part of the State, being grown by irrigation supplied by the Platte River.

McCOOK.—Results in growing beets at this point have been so favorable that the farmers and business men in that section have been agitating the erection of a sugar factory and devoting some of their lands to the production of sugar beets. Considerable progress has been made toward establishing a factory. Local interests have the assurance from those interested in other beet-sugar factories that if sufficient acreage is pledged a factory will be built. It is probable that a factory of at least 500 tons' daily capacity will be in operation at this place no later than 1904.

OTHER PLACES.—There are several points in addition to McCook at which the establishment of factories is seriously contemplated. Among these are the following: Plattsmouth, Chadron, and Culbertson.

KANSAS.

The State experiment station carried on extensive experiments at the time other States were testing their conditions. These tests were confined mostly to the eastern portions of the State. Its reports were discouraging to the introduction of the beet-sugar industry. The

establishment in the eastern part of Colorado of factories at Rockyford and Sugar City revived the experiments and interest in the western part of the State. Sugar beets were grown and shipped to the factory at Rockyford. The results of these trials were so encouraging that there has been considerable talk about introducing beet-sugar manufacturing in western Kansas. Two years ago the legislature was induced to offer $1 a ton for all sugar beets grown in the State, and $10,000 was appropppriated to pay the same. Each year has seen an increase in the production. There still remains about $4,000 of this bounty, and parties interested in sugar-beet growing are importuning the legislature to increase the amount. It is quite possible that two or three factories may be constructed. The following places appear prepared to furnish the acreage required and are striving to secure the interest of capitalists in building factories: Hutchinson, Wichita, Lakin, and Garden City.

IOWA.

This is one of the States in which elaborate experiments have been carried out by the experiment stations and by local organizations. Every part of the State has been quite thoroughly tested as to its conditions for growing sugar beets. In fact, in several localities sugar beets have been grown for factory use. Storm Lake, Fort Dodge, and Cedar Falls have grown several hundred acres for the factory at St. Louis Park, Minn. Nearly all of these points have been objects of careful consideration on the part of capitalists and farmers, with a view to establishing beet-sugar factories. There is no question about the existence of favorable conditions at these points, and capitalists who have looked into the matter are well assured of that fact. The difficulty has always grown out of the reluctance of the farmers to grow beets. I am more and more assured every year of the resourcefulness of the State of Iowa should it engage in beet-sugar production. It has the feeding and creamery interests, the railroads, the fuel; it has good market facilities for this product; it has generally an intelligent, industrious farming class; it has live, energetic organizations representing all features of agriculture, and it has considerable local capital. Iowa appears to take front rank in almost everything the people undertake in the way of crops or animal production. It probably could excel any other State in certainty of a crop year after year with a higher tonnage of sugar beets having sufficient sugar content and purity. The question naturally arises, "Why, with all their apparent advantages, have not the people of Iowa secured the establishment of the beet-sugar industry?" My view of the matter is this: The very prosperity of the State, with its diversified interests in agriculture, is the drawback. The farmers are prosperous, as a rule, in their present occupations, whatever may be their particular product.

They are not looking for some new industry, one which has the reputation of requiring so much expense and laborious work. I notice the sugar industry is going to the States where agriculture is new and where necessity requires the introduction of new crops in order to develop natural resources and take advantage of natural facilities. However, there is hope that some factories may be built. I confidently look for the establishment of several in the State within the next few years.

COUNCIL BLUFFS.—An organization was recently effected with a capital of a million dollars having in view the building of a beet-sugar factory near Council Bluffs. A short distance north of this place, at Missouri Valley, from 1,100 to 2,000 acres of beets have been grown annually for the last three years for the factory at Leavitt, Nebr. These beets have been of good quality and tonnage per acre.

SIOUX CITY.—Parties are interested in stimulating the building of a beet-sugar factory at Sioux City, with some indications of success.

WISCONSIN.

CHIPPEWA FALLS.—It is stated on good authority that the Wisconsin Sugar Company will construct a factory at this place, having a 600-ton daily capacity, to engage in the campaign of 1903.

JANESVILLE.—From Janesville I am informed that the Wisconsin Sugar Company has proposed to the business men that it will construct at this place a factory of 500 tons daily capacity, provided sufficient acreage can be secured for the campaign of 1904.

CORLISS.—It is claimed by the local business men of this place that they have sufficient assurance of acreage and capital for establishing a 500-ton sugar plant at that place for operation in 1903 or 1904.

GREENBAY.—The Fox River Beet Sugar Company at this place has secured sufficient capital and nearly enough acreage for constructing a beet-sugar factory of 600 tons daily capacity to engage in the campaign of 1903.

It is claimed that the Wisconsin Beet Sugar Company also proposed to the business men of this vicinity that it would build a 500-ton plant if 4,000 acres pledged for growing sugar beets for three years could be secured. A sugar factory of this capacity will probably be in operation during the campaign of 1903.

KAUKAUNA.—It is authentically stated that a 500-ton sugar factory will be built at this place to be ready for the campaign of 1903.

MILWAUKEE.—For some time there has been considerable talk about constructing a large factory at Milwaukee having a daily capacity of 1,000 tons, capital to be furnished by wholesale and retail grocers. I am now authentically informed that this proposition has been matured and such a factory will be in operation at that place no later than 1904.

OTHER PLACES.—There are several other places in this State that have plans more or less matured that seem likely to culminate, eventually, in actual beet-sugar enterprises. These places are negotiating with capitalists, securing contracts for growing sugar beets, have local organizations, and are energetically pushing to the end of securing factories. The most important of these are as follows: Eau Claire, Racine, Sturgeon Bay, and Watertown.

ILLINOIS.

CHICAGO.—There has been considerable talk for some time by Chicago capitalists about erecting a large sugar refinery in Chicago and several beet-sugar factories at towns in the near vicinity. I believe this project contemplates that wholesalers and large grocers are to be the principal stockholders. Of course this scheme contemplates that those interested would also have the facilities for marketing the sugar. It looks quite probable that something of the kind will occur in Illinois not far in the future and that the State is liable to find itself the possessor of several sugar factories all under one combination.

There are quite a number of other places in Illinois where capitalists, business men, and farmers are agitating the erection of sugar factories, and it is probable that at some of these factories will be built sooner or later.

MICHIGAN.

Michigan, like Colorado, comes in with a long list of projects, most of which are likely to materialize. The interest in Michigan and Colorado is undoubtedly inspired by the large number of factories already in operation in these States. It is one of the best signs of the prosperity of the industry that so many new factories are contemplated in the localities where the industry is best known.

ALPENA.—It is announced that a factory has been secured for this place for the campaign of 1903 having a daily capacity of 600 tons. Most of the acreage has been pledged and capitalists have agreed to construct a factory. Indications point to its completion for 1903 or 1904.

BADAXE.—Capitalists have agreed to construct a sugar factory of 500 tons daily capacity at this place, provided water of sufficient quantity and purity can be produced. This has caused persons interested to sink deep wells, and it is claimed that they now have an abundant supply of pure water and the factory will be in operation for 1903 or 1904.

EAST TAWAS.—A local company at this place has secured sufficient acreage and has let the contract for building a sugar factory having a daily capacity of 600 tons to be completed for the campaign of 1903.

ENCORSE.—The Detroit River Sugar Company has let the contract

for a 600-ton sugar factory to be erected between the towns of River-rouge and Encorse. It is the purpose of this company to buy its own lands and grow its own beets and to be in operation for the campaign of 1903.

GLADSTONE.—Capital has been subscribed and most of the acreage secured for constructing a 500-ton sugar factory at this place to be in operation for the campaign of 1903.

MENOMINEE.—The Menominee River Sugar Company is building a factory at this place of 1,000 tons capacity for operation in the campaign of 1903.

TRAVERSE CITY.—The farmers around this place have agreed to raise 5,000 acres of sugar beets if a factory is established. Parties interested in other sugar factories have agreed to place the factory. Potatoes is the staple crop of this community, and the farmers are very well versed in growing root crops, and have had more or less experience in growing sugar beets for other factories. They are growing a large acreage of sugar beets for other factories for 1903, and it is quite likely that a sugar factory of 600 tons daily capacity will be established here for the campaign of 1904.

MOUNT PLEASANT.—A factory is building at this place for operation in the campaign of 1903, with a daily capacity of 600 tons.

Owosso.—The Owosso Sugar Company is building a factory at this place for the campaign of 1903, with a daily capacity of 1,000 tons. This company has purchased 8,000 acres of land to assure a sufficient acreage of beets. It is not intended that the company shall grow all the beets needed, but that this amount of land will guarantee it a sufficient supply each season. This is a wise provision and suggestive to future factory builders in this State.

ST. LOUIS.—A sugar company organized at this place has secured nearly enough acreage, and has entered into a contract with a construction company for building a 600-ton plant, to be in operation during the campaign of 1903.

OTHER PLACES.—There are quite a number of other places in Michigan that have made more or less progress toward establishing sugar factories. Most of them have local organizations, a certain amount of acreage pledged, and more or less capital subscribed, and are in negotiation with capitalists and others with a view to maturing their plans. The following are some of the places at which factories are most probable: Sault Ste. Marie, Ypsilanti, Monroe, Portland, Mason, Manistique, Marquette, Houghton, Lapeer, Cheboygan, Marinette, Escanaba, Dundee, Battle Creek, and Cass City.

INDIANA.

From the beginning this State has been active through the work of the State Experiment Station and private parties in testing soil conditions with a view to establishing beet-sugar factories in different portions of the State. There are many places where indications point to the successful growing of sugar beets. The State has many natural advantages in the way of markets, transportation facilities, fuel, etc. A company organized and actually began constructing a factory at Shelby. Contracts had been made with the farmers, but the project was abandoned for some reason and the beets were sold to some other factory. Experiments in growing sugar beets and agitation in factory building has continued. At the present time the following places appear quite likely to have beet-sugar factories sooner or later: Butler, Fort Wayne, Vincennes, and Shelby.

OTHER STATES.

There is more or less well-developed interest in the State of New York looking to the establishment of other beet-sugar factories. The most probable locations are Le Roy, Newpaltz, and Troy.

At several places in Ohio, Pennsylvania, and Virginia the establishment of beet-sugar factories is receiving serious consideration. At each place experiments are being made and local organizations have been formed. The most prominent among these places are Dayton, Ohio; Philadelphia and Harrisburg, Pa.; and Newport News, Va.

STATISTICS OF THE SUGAR INDUSTRY.

The statistics of production of sugar beets, and manufacture of sugar therefrom, have been collected directly from the factories themselves. Statistics of consumption, imports, exports, etc., have been drawn from the most reliable sources.

STATISTICS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES FOR 1902.

In the following table are compiled the results achieved by the beet-sugar factories and the beet growers of the United States in 1902. Most of the data came directly from the factories themselves. The acres planted, acres harvested, tons of beets worked, and amount of sugar produced were reported to me by the factories except in four cases. In three of these cases the reports are semiofficial from other sources. In one case only these items are estimated, the estimates being based on length of campaign last year, capacity of the factory, and comparison with results accomplished by other factories having like conditions during the past year. All the other figures appearing in this table have been taken from factory reports to me, with the

exception of some items which have been estimated from reliable data, and which are so indicated. More than half of the factories reported fully. The best reported only acreage, tonnage, and production of sugar. I regret that I could not include complete data from all these factories, as the results indicate so clearly the things to which we need to direct our attention in manufacturing sugar. The farm results brought out are interesting and instructive.

In order that the identity of the factories may not be revealed I have represented each factory by a number, the same number being used for the same factory in all the tables:

Factory and farm results for 1902.

Factory No.	Beet production.			Beets worked.			Average sugar—		Average purity coefficients—	
	Area planted.	Area harvested.	Average yield per acre.	Total amount.	Average cost per ton.	Total cost.	In beets.	In juice.	Of beets.	Of juice.
	Acres.	*Acres.*	*Tons.*	*Tons.*			*Per ct.*	*Per ct.*		
1				16,944			13.2		83.5	
2	3,000	1,800	9.0	15,032	$5.50	$83,050.00	13.8	11.7	84.8	84.8
3				26,000						
4	9,350	7,400	5.6	42,684	5.46	a 233,054.64	13.6	14.6	85.1	83.4
5				22,000						
6	9,630	9,460	a 6.8	64,063	5.25	336,654.00	13.3	9.9	83.9	84.9
7	4,800	3,600	7.5	28,000	5.25	147,000.00	13.5			
8	8,200	7,500	a 6.0	45,000						
9	4,627	3,742	7.3	27,319	5.46	149,228.80	13.9	15.1	85.1	
10				30,000						
11				4,676						
12	5,500	5,000	7.5	38,499	5.39	201,323.98	14.7			
13	7,000	6,000	6.5	39,900	5.03	200,610.94	13.7		81.0	
14		3,500	a 8.2	28,800						
15	7,124	6,651	a 7.3	48,273						
16	5,300	4,000	a 6.4	25,662						
17				14,000						
18	8,000	4,000	a 5.6	22,532						
19				30,000						
20				30,800						
21	4,180	3,696	10.0	36,884	4.53	166,962.49	12.1	12 7	76.4	78.9
22				109,307						
23				41,000						
24	4,350	3,534	8.5	28,332	5.00	150,226.84	14.8	16.4	82.2	82.2
25				40,000						
26	10,200	9,300	12.5	113,670	a 4.50	511,515.00	15.4		84.8	
27	4,250	4,200	10.0	42,472	4.65	a 197,494.80	13.8	15.2	82.1	81.8
28	5,500	4,672	8.0	35,856	4.50	168,232.93	14.8		84.4	84.6
29	8,597	8,147	10.2	89,110	4.93	439,411.90	14.8	15.9	83.6	83.6
30	5,200	5,113	a 9.6	48,970						
31 b										
32	6,800	5,900	7.5	42,359	5.05	214,135.87	18.2	19.7	84.2	84.2
33	10,599	8,822	a 11.1	c 85,957						
34	7,004	5,046	7.0	35,133	5.50	a 193,231.50	17.3	13.0		77.4
35	21,569	17,662	11.2	197,949	4.70	932,116.69				
36	18,327	17,690	a 10.7	189,618						
37	5,036	4,192	8.9	37,219	4.50	167,650.66	15.7			78.7
38	3,800	3,500	a 9.1	32,000	4.92	157,241.01	14.8		84.0	
39				18,750						
40				38,500						
41				17,888						
42	2,000	2,000	8.0	14,654	5.50	80,000.00	16.0		84.0	
Total and average			8.4	1,895,812	5.03		14.6	14.4	83.3	82.2

a Estimated. b Not working this year. c 11,648 tons shipped to another factory.

Factory and farm results for 1902—Continued.

Factory No.	Sugar.					Campaign.		
	Amount produced.		Average net selling price per hundredweight.	Seconds, beginning of campaign.	Seconds held for future campaign.	Opened.	Closed.	Number of days.
	Pounds.	Tons.		*Pounds.*	*Pounds.*			
1	3,206,782	1,603.39						
2	3,100,000	1,550.00	$4.38	20,000		Oct. 20,1902	Dec. 12,1902	54
3	5,460,000	2,730.00						
4	9,550,000	4,775.00				Oct. 10,1902	Jan. 28,1903	111
5	4,800,000	2,400.00						
6	14,481,135	7,240.57		100,351	84,906	Oct. 20,1902	Jan. 22,1903	95
7	5,600,000	2,800.00				Oct. 14,1902	Jan. 12,1903	91
8	9,300,000	4,650.00						
9	6,246,039	3,123.02	4.38	118,561	127,179	Oct. 13,1902	Jan. 6,1903	86
10	6,000,000	3,000.00						
11	936,103	468.05						
12	7,323,468	3,661.73	4.60			Oct. 9,1902	Jan. 21,1903	105
13	8,200,000	4,100.00				Oct. 8,1902	Jan. 9,1903	94
14	5,614,000	2,807.00						
15	9,500,000	4,750.00						
16	5,400,000	2,700.00						
17	2,441,674	1,220.84						
18	4,327,532	2,163.77						
19	6,500,000	3,250.00						
20	7,000,000	3,500.00						
21	7,613,500	3,806.75	4.51	374,000	528,000	Sept. 15,1902	Dec. 24,1902	101
22	29,529,700	14,764.85						
23	10,500,000	5,250.00						
24	6,777,100	3,388.55	4.28		22,105	Oct. 22,1902	Dec. 14,1902	54
25	8,000,000	4,000.00						
26	25,650,000	12,825.00				Sept. 27,1902	Jan. 19,1903	a 103½
27	8,885,800	4,442.90	4.75	107,000	118,000	Sept. 3,1902	Dec. 27,1902	116
28	7,830,300	3,915.15	4.75	73,800	150,900	Sept. 16,1902	Dec. 21,1902	97
29	20,802,000	10,401.00	4.39	1,508,533	2,225,173	Sept. 22,1902	Dec. 26,1902	96
30	12,848,000	6,424.00						
31 b								
32	10,153,500	5,076.75	4.02	115,624	83,129	July 27,1902	Nov. 4,1902	101
33	20,500,000	10,250.00						
34	10,032,580	5,016.29	3.97			Aug. 15,1902	Nov. 5,1902	83
35	43,214,000	21,607.00				Sept. 9,1902	Dec. 22,1902	105
36	53,336,500	26,668.25						
37	8,459,000	4,229.50				July 21,1902	Nov. 4,1902	107
38	8,706,372	4,353.19	4.55		1,919,000	Sept. 27,1902	Jan. 8,1903	104
39	3,750,000	1,875.00						
40	7,000,000	3,500.00						
41	4,560,000	2,280.00						
42	3,676,600	1,838.30	5.00			Sept. 22,1902	Dec. 10,1902	80
Total and average	436,811,685	218,405.85	4.46					94

a Of this time, 11½ days were lost.

b Not working this year.

Factory and farm results for 1902—Continued.

Factory No.[a]	Fuel used.						Limestone used.			Factory labor and wages.					
	Bituminous coal.		Coke.		Oil.					Common labor.			Skilled labor.		
	Amount.	Cost per ton.	Amount.	Cost per ton.	Amount.	Cost per barrel.	Amount.	Cost per ton.	Lime content.	Number employed for campaign.	Average daily wages.	Total amount paid.	Number employed for campaign.	Average daily wages.	Total amount paid.
	Tons.		*Tons.*		*Bbls.*		*Tons.*		*P. ct.*						
2	3,000	$3.00	75	$6.00	.....	.....	1,000	$1.40	.....	180	$1.50	$14,300	40	$2.50	$5,300
4	10,772	2.56	400	7.15	.....	.....	2,122	2.00	95.3	190	2.02	[b]42,602	14	.....	.....
6	13,074	2.64	739	.....	.....	.....	6,644	1.89	52.6	333	1.90	[b]60,106	47	2.80	69,152
7	[b]5,572	3.50	150	10.50	.....	.....	1,500	2.25	.....	.....	.....	.....	.....	.....	.....
9	5,097	2.65	223	4.75	.....	.....	1,611	2.52	97.0	107	1.75	21,453	11	3.00	10,652
12	10,632	3.12	264	5.05	.....	.....	[b]3,388	1.96	.....	300	[b]2.16	48,144	.....	.....	.....
13	8,700	2.55	262	5.14	.....	.....	2,049	2.05	96.0	214	1.69	33,634	39	3.10	11,244
21	8,896	2.50	616	7.15	.....	.....	5,395	1.70	40.0	250	2.00	49,098	.....	.....	.....
24	8,193	2.43	220	9.67	.....	.....	2,251	2.73	97.0	220	2.00	[b]23,760	20	4.00	[b]4,320
26	[c]27,000	[b]3.00	720	.....	.....	.....	6,870	[b]2.00	.....	365	[b]2.16	[b]81,599	.....	.....	.....
27	[b]8,452	2.56	169	16.25	.....	.....	1,706	1.87	.....	[b]90	1.80	[b]18,792	[b]10	2.50	35,280
28	6,097	2.50	166	15.50	.....	.....	1,706	1.68	90.6	120	2.00	9,519	.....	.....	24,302
29	12,991	3.25	460	16.00	.....	.....	4,781	2.25	95.0	300	2.00	[b]57,600	8	4.50	63,000
32	.....	.....	188	3.25	24,910	$0.52	2,296	2.35	98.0	130	2.25	29,548	13	3.15	4,136
34	.....	.....	248	12.00	35,825	.72	2,869	2.14	.....	170	2.10	28,917	45	3.50	12,757
37	.....	.....	238	14.13	24,679	.72	2,965	1.95	.....	95	1.96	19,852	49	2.64	13,959
38	7,750	3.06	185	8.09	.....	.....	1,645	1.75	95.0	150	1.92	[b]29,952	12	3.25	[b]4,056
42	3,000	5.25	118	11.65	.....	.....	1,082	2.73	.....	110	2.00	[b]17,600	10	4.00	[b]3,200
Average..	.....	2.97	.....	9.52	.....	.65	.....	2.07	85.6	.....	1.95	.....	.....	3.24	.....

[a] In cases where factories failed to report data under these heads, the numbers are omitted.
[b] Estimated.
[c] Lignite.

Factory and farm results for 1902—Continued.

Factory No.[a]	Pulp.				Waste molasses.				Process used in treating molasses.
	Amount produced.	Amount sold.	Price per ton.	Sugar passed with cossettes.	Amount produced.	Content of sugar.	Amount sold.	Price per gallon.	
	Tons.	*Tons.*	*Cents.*	*P. ct.*	*Gallons.*	*P. ct.*	*Gallons.*	*Cents.*	
2	9,000	9,000	.....	0.38	13,000	48.0	13,000	.....	Crystallization.
4	.....	.....	.....	.35	.....	.....	.....	.....	Crystallization. Osmose.
6	Not weighed.	.....	Given away.	.28	135,000	49.8	.....	.....	Crystallization. Steffin.
9	23,221	.....	.....	.34	127,114	50.2	63,500	1	Crystallization.
12	.....	2,000	10	.....	[b]303,384	44.0	[b]303,384	1	Crystallization. Osmose.
13	35,000	.....	.....	.25	.....	.....	.....	.....	Crystallization.
21	.....	.....	.....	.57	.....	.....	.....	.....	Steffin.
24	14,000	14,000	30	.....	[b]198,133	50.0	.....	.....	Crystallization. Osmose.
27	20,000	20,000	50	.53	325,650	53.0	.....	.....	Crystallization.
28	11,000	11,000	50	.41	272,857	59.0	.....	.....	Grosse, Osmose.
29	35,000	15,000	30	.22	.....	.....	.....	.....	Crystallization. Osmose.
32	20,000	20,000	52	.95	635,000	52.8	73,959	2	Crystallization.
34	21,080	21,080	20	.44	201,690	43.3	201,690	16	Do.
37	.....	15,000	10	.48	.....	49.0	47,136	.....	
38	27,000	27,000	45	.....	[b]306,884	.....	[b]306,884	2	Do.
42	.....	.....	.....	1.00	.....	.....	.....	.....	Do.
Average.	.....	.....	30	.48	.....	49.9	.....	4.4	

[a] Numbers of factories which did not report data coming under these heads are omitted.
[b] Estimated.

Factory and farm results for 1902—Continued.

Factory No.[a]	Largest average yield of beets per acre.							Price paid for beets.[b]		Freight rates, per ton, on beets.	Greatest quantity of beets worked in one day.
	Under any contract.				Under any contract of 10 acres or over.						
	Area.	Yield.	Sugar in beets.	Purity coefficient.	Yield.	Sugar in beets.	Purity coefficient.	Minimum or straight.	Additional scale.		
	Acres.	*Tons.*	*P. ct.*		*Tons.*	*P. ct.*		*Dollars.*	*Cents.*	*Cents.*	*Tons.*
2	2	24	13.0	84.0	20	13.5	84.0	5.00	.....	50	390
4	.....	.....	.....	.....	.....	.....	.....	4.50	33⅓	40 to 80	728
6	2	21	13.8	81.0	14	14.2	84.0	4.50	33⅓	40, 60, 80	1,178
7	.....	.....	.....	.....	.....	.....	.....	4.50	33⅓	.....	.....
9	1	17	13.5	.....	9	14.9	.....	4.50	33⅓	30 to 100	420
12	2	22	13.5	.....	14	14.5	.....	4.50	33⅓	.....	750
13	12	18	12.5	80.0	14	13.5	83.0	4.50	33⅓	40 to 60	.....
21	3	24	15.8	81.7	16	12.5	80.0	4.00	25	50 to 85	585
24	5	26	15.1	82.2	18	15.1	82.2	4.88	.....	30	685
26	15	32	.....	.....	.....	.....	.....	.....	.....	.....	.....
27	3	29	14.0	81.0	17	14.2	81.5	3.50	.....	35 to 50	350
28	2	20	.....	.....	20	16.0	87.7	4.50	.....	35	496
29	4	25	15.0	82.5	19	16.1	83.4	4.75	.....	100	1,175
32	2	35	19.0	84.0	10	18.0	84.0	3.00	25	Hauled.	755
34	.....	.....	.....	.....	.....	.....	.....	.....	.....	50 to 60	943
37	23	38	12.7	76.9	38	12.7	76.9	4.50	.....	30 to 55	510
38	2	22	15.2	84.6	16	14.0	83.5	4.85	.....	50 to 85	.....
42	5	14	.....	.....	10	.....	.....	.....	.....	50	270
Total and average	.....	.....	14.4	81.8	.....	14.6	82.7	4.40	31⅓	.....	.....

[a] Numbers of factories which did not report data under these heads are omitted.
[b] At some factories a straight price per ton is paid for all acceptable beets; at others a minimum is fixed for beets having a certain percentage of sugar (usually 12 per cent), and an additional amount is paid for each additional 1 per cent of sugar in the beets.

In the table following (p. 118) appear several columns of very interesting data, not directly reported by the factories, but derived from the figures so reported. The most important data appearing in the preceding tables are repeated here in order to show clearly the source from which the other figures are derived.

Summary of factory results, with additional data derived therefrom.

Factory No.	Beet production.				Beets worked.		Coal used.		Fuel oil used.		Limestone used.		Ratio of materials to beets.a			Cost of working beets per ton.				Factory extraction of sugar.	Sugar produced.	
	Area planted.	Area harvested.	Average yield per acre.	Part of area harvested.	Amount.	Cost.	Amount.	Cost.	Amount.	Cost.	Amount.	Cost.	Coal.	Fuel oil.	Limestone.	Labor.	Coal.	Fuel oil.	Limestone.		Per acre.	Per ton of beets.
	Acres.	*Acres.*	*Tons.*	*P. ct.*	*Tons.*		*Tons.*		*Bbls.*		*Tons.*		*P. ct.*	*P. ct.*	*P. ct.*		*Cents.*	*Cents.*	*Cents.*	*P. ct.*	*Lbs.*	*Lbs.*
1					16,944															9.46		189
2	3,000	1,800	9.0	60.0	15,032	$83,050.00	3,000	$9,000			1,000	$1,400	20.0		6.7	$0.970	59.9		9.3	9.78	1,722	196
3					26,000															10.50		210
4	9,350	7,400	5.6	79.1	42,684	b 233,054.64	10,772	27,576			2,122	4,244	25.2		5.0	b .998	64.6		9.9	11.19	1,291	224
5					22,000															10.91		218
6	9,630	9,460	b 6.8	98.2	64,063	336,654.00	13,074	34,515			6,644	12,557	20.4		10.4	b .938	53.9		19.6	11.30	1,531	226
7	4,800	3,600	7.5	75.0	28,000	147,000.00	b 5,572	19,502			1,500	3,375	b 19.9		5.4		b 69.6		12.1	10.00	1,556	200
8	8,200	7,500	b 6.0	91.5	45,000															10.33	1,240	207
9	4,627	3,742	7.3	80.9	27,319	149,223.80	5,097	13,507			1,611	4,060	18.7		5.9	.785	49.4		14.9	11.43	1,669	229
10					30,000															10.00		200
11					4,676															10.01		200
12	5,500	5,000	7.5	90.9	38,499	201,323.98	10,632	33,172			b 3,388	b 6,640	27.6		b 8.8	1.251	86.2		b 17.2	9.51	1,465	190
13	7,000	6,000	6.5	85.7	39,900	200,610.94	8,700	22,185			2,049	4,200	21.8		5.1	.843	55.6		10.5	10.28	1,367	206
14		3,500	b 8.2		28,800															9.75	1,604	195
15	7,124	6,651	b 7.3	93.4	48,273															9.84	1,428	197
16	5,300	4,000	b 6.4	75.5	25,662															10.52	1,350	210
17					14,000															8.72		174
18	8,000	4,000	b 5.6	50.0	22,532															9.60	1,082	192
19					30,000															10.83		217
20					30,800															11.36		227
21	4,180	3,696	10.0	88.4	36,884	166,962.49	8,896	22,240			5,395	9,172	24.1		14.6	1.331	60.3		24.9	10.32	2,060	206
22					109,307															13.51		270
23					41,000															12.80		256
24	4,350	3,534	8.5	81.2	28,332	150,226.84	8,193	19,919			2,251	6,144	28.9		7.9	b .839	70.3		21.7	11.96	1,918	239
25					40,000															10.00		200
26	10,200	9,300	12.5	91.2	113,670	511,515.00	27,000	b 81,000			6,870	b 13,740	23.8		6.0	b .718	b 71.3		b 12.1	11.28	2,758	226
27	4,250	4,200	10.0	98.8	42,472	b 197,494.80	b 8,452	b 21,687			1,706	3,190	b 19.9		4.0	.442	b 51.0		7.5	10.46	2,116	209
28	5,500	4,672	8.0	84.9	35,856	168,282.93	6,097	15,242			1,706	2,866	17.0		4.8	.649	42.5		8.0	10.92	1,676	218
29	8,597	8,147	10.2	94.8	89,110	439,411.90	12,991	42,221			4,781	10,757	14.6		5.4	b .646	47.4		12.1	11.67	2,553	233
30	5,200	5,113	b 9.6	98.3	48,970															13.12	2,518	262
31 c																						
32	6,800	5,900	7.5	86.8	42,359	214,135.87			24,910	$12,953	2,296	5,396		58.8	5.4	.698		30.6	12.7	11.99	1,721	240
33	10,599	8,822	b 11.1	83.2	d 85,957															11.92	2,324	238
34	7,004	5,046	7.0	72.0	35,133	198,231.50			35,825	25,978	2,869	6,141		102.0	8.2	.823		73.9	17.5	14.28	1,988	286

35	21,569	17,662	11.2	81.9	197,949	932,116.69													10.92	2,447	218
36	18,827	17,690	b 10.7	96.5	189,618														14.06	3,015	281
37	5,036	4,192	8.9	88.2	37,219	167,650.66			24,679	17,645	2,965	5,781		60.3	8.0	.533		47.4	15.5	11.38	2,018	227
38	8,800	3,500	b 9.1	92.1	32,000	157,241.01	7,750	23,715			1,645	2,879	24.2		5.1	b .936	74.1		9.0	13.80	2,488	272
39					18,750															10.00		200
40					38,500															9.09		182
41					17,888															12.75		255
42	2,000	2,000	8.0	100.0	14,654	80,000.00	3,000	15,750			1,082	2,964	20.5		7.4	b 1.201	107.5		20.2	12.54	1,838	251
Total and average			8.4	85.1	1,895,812								21.8	75.7	6.9	.859	64.2	50.6	14.2	11.07	1,879	221

a The percentage figures in these columns simply express the ratio between the number of tons of beets on the one hand and the number of tons, barrels, or cords on the other.

b Estimated.

c Not working this year.

d 11,648 tons shipped to another factory.

The following table shows the best results achieved by farmers growing beets, as reported by 15 different factories. It shows the number of acres cultivated and the results. From the data given and other data available I have worked out the results achieved by the factories in working up the beets produced by these most successful growers.

Best crops of beets grown at 15 factories, and factory results with the same crops of beets.

Factory No.[a]	Beets.							Sugar.				
	Area.	Yield per acre.	Total crop.	Average price per ton.	Cash returns per acre.	Sugar in beets.	Purity coefficient.	Factory extraction.	Per ton of beets.	Per acre.	Average price per pound.	Value per acre.
	Acres.	*Tons.*	*Tons.*			*P. ct.*		*P. ct.*	*Lbs.*	*Lbs.*	*Cents.*	
2	2	24	48	$5.50	$132.00	13.0	84.0	9.78	196	4,704	4.38	$206.04
6	2	21	42	5.25	110.25	13.8	81.0	11.30	226	4,746	.....	.....
9	1	17	17	5.46	92.82	13.5	[b]85.1	11.43	229	3,893	4.38	170.51
12	2	22	44	5.39	118.58	13.5	.....	9.51	190	4,180	4.60	192.28
13	12	18	216	5.03	90.54	12.5	80.0	10.28	206	3,708	.....	.....
21	3	24	72	4.53	108.72	15.8	81.7	10.32	206	4,944	4.51	222.97
24	5	26	130	5.00	130.00	15.1	82.2	11.96	239	6,214	4.28	265.96
26	15	32	480	4.50	144.00	[b]15.4	[b]84.8	11.28	226	7,232	.....	.....
27	3	29	87	4.65	134.85	14.0	81.0	10.46	209	6,061	4.75	287.90
28	2	20	40	4.50	90.00	[b]14.8	[b]84.4	10.92	218	4,360	4.75	207.10
29	4	25	100	4.93	123.25	15.0	82.5	11.67	233	5,825	4.39	256.72
32	2	35	70	5.05	176.75	19.0	84.0	11.99	240	8,400	4.02	337.68
37	23	38	874	4.50	171.00	12.7	76.9	11.36	227	8,626	.....	.....
38	2	22	44	4.92	108.24	15.2	84.6	13.60	272	5,984	4.55	272.27
42	5	14	70	5.50	77.00	[b]16.0	[b]84.0	12.54	251	3,514	5.00	175.70
Average	.....	.....	.....	4.98	120.53	14.8	82.6	11.42	228	5,493	4.46	235.83

[a] The factory numbers are the same here as in the previous tables.
[b] The figures for these beets not being available, the averages given in table on page 114 are used.

The following table is interesting as showing the development of the industry in the various States. It will be seen from this that California is considerably in the lead, while Michigan, Colorado, and Utah occupy second, third, and fourth places, respectively.

Beets worked and sugar produced in 1902, by States.

State.	Amount of beets worked.	Amount of sugar produced.	
		Pounds.	Tons.
	Tons.		
New York	32,606	6,271,248	3,135.57
Michigan	507,408	105,179,951	52,589.91
Nebraska	97,684	21,113,500	10,556.75
Colorado	332,309	80,456,800	40,218.40
Utah	167,438	37,518,100	18,759.05
California	637,204	158,543,580	79,271.79
Minnesota	32,000	8,706,372	4,353.18
Ohio	18,750	3,750,000	1,875.00
Wisconsin	38,500	7,000,000	3,500.00
Oregon	17,888	4,560,000	2,280.00
Washington	14,654	3,676,600	1,838.30

MISCELLANEOUS SUGAR STATISTICS.

The following tables, except the last, which contains the sugar crops of the world, were compiled by the Division of Foreign Markets, Department of Agriculture. These tables present some very interesting data touching the production and consumption of sugar; also information as to imports of sugar into the United States, and the average prevailing price of sugar during 1902.

Production of beet and cane sugar in the United States.[a]

Year.	Beet.	Cane (Louisiana).	Total.[b]
	Tons.[c]	*Tons.*[c]	*Tons.*[c]
1883-84	535	128,443	128,978
1884-85	953	94,376	95,329
1885-86	600	127,958	128,558
1886-87	800	80,859	81,659
1887-88	255	157,971	158,226
1888-89	1,861	144,878	146,739
1889-90	2,203	130,413	132,616
1890-91	3,459	215,844	219,303
1891-92	5,356	160,937	166,293
1892-93	12,018	217,525	229,543
1893-94	19,950	265,836	285,786
1894-95	20,092	317,334	337,426
1895-96	29,220	237,721	266,941
1896-97	37,536	282,009	319,545
1897-98	40,398	310,313	350,711
1898-99	32,471	248,658	281,129
1899-1900	72,972	142,485	215,457
1900-1901	76,859	270,338	347,197
1901-2	163,126	310,000	473,126
1902-3	195,463	280,000	475,463

[a] Data as to beet sugar are obtained from the following sources: For 1899-1900, from the Eleventh Census; for 1897-98, from a special report of the Department of Agriculture; and for other years, from Willett & Gray. Data as to cane sugar are from the following sources: For 1889-90, 1898-99, and 1899-1900, from the Eleventh and Twelth censuses; for 1901-2 and 1902-3, from Willett & Gray; for other years, from Bouchereau's Annual Louisiana Sugar Reports (the figures for 1892-93 being taken from his revised statement).

[b] These figures do not include cane sugar produced outside of Louisiana; in 1889-90 such sugar amounted to 4,089 tons and in 1899-1900, to 1,510 tons.

[c] Tons of 2,240 pounds.

Production of cane sugar in dependencies of the United States for the crop years 1898-99 to 1902-3.[a]

Dependency.	1898-99.	1899-1900.	1900-1901.	1901-2.	1902-3.
	Tons.[b]	*Tons.*[b]	*Tons.*[b]	*Tons.*[b]	*Tons.*[b]
Hawaii	252,506	258,521	321,461	317,509	349,000
Porto Rico	53,825	35,000	80,000	85,000	85,000
Philippine Islands	93,000	62,785	55,400	78,637	80,000
Total	399,331	356,306	456,861	481,146	514,000

[a] According to estimates of Willett & Gray; the statistics given for the Philippine Islands are export returns and not production returns.

[b] Tons of 2,240 pounds.

Imports of sugar into the United States, 1883–1902.

Year ended June 30—	Pounds.	Tons.[a]	Value.
1883	2,187,819,123	954,384	$91,637,992
1884	2,756,416,896	1,230,543	98,262,607
1885	2,717,884,653	1,213,341	72,519,514
1886	2,689,881,765	1,200,840	80,773,744
1887	3,136,443,240	1,400,198	78,411,224
1888	2,700,284,282	1,205,484	74,245,206
1889	2,702,202,967	1,233,126	88,543,971
1890	2,934,011,560	1,309,827	96,094,532
1891	3,483,477,222	1,555,124	105,728,216
1892	3,550,709,165	1,587,727	104,408,813
1893	3,766,445,347	1,681,449	116,255,784
1894	4,345,193,881	1,939,819	126,871,889
1895	3,574,510,454	1,595,764	76,462,836
1896	3,898,338,557	1,739,437	89,219,773
1897	4,918,905,733	2,195,940	99,066,181
1898	2,689,920,851	1,200,858	60,472,749
1899	3,980,250,569	1,776,898	94,964,120
1900	4,018,086,530	1,793,789	100,250,974
1901[b]	4,803,088,500	2,144,236	122,276,999
1902[b]	3,936,286,281	1,757,271	84,871,299

[a] Tons of 2,240 pounds.

[b] As in earlier years, including shipments from Hawaii and Porto Rico to the United States. For 1901 the shipments from Hawaii amounted to 690,880,832 pounds, or 308,429 tons, valued at $27,094,095, and from Porto Rico 137,201,828 pounds, or 61,251 tons, valued at $4,695,104. For 1902 the shipments from Hawaii amounted to 720,553,357 pounds, or 321,676 tons, valued at $23,920,113, and from Porto Rico 183,817,049 pounds, or 82,061 tons, valued at $5,890,089.

Consumption of sugar in the United States, 1893–1902.

Calendar year.	Total amount of sugar consumed.[a]	Increase (+) or decrease (−) as compared with previous year.		Consumption per capita.
	Tons.[b]	*Tons.*[b]	*Per cent.*	*Pounds.*
1883	1,170,375	+109,155	+10.29	48.83
1884	1,252,366	+ 81,991	+ 7.01	51.09
1885	1,254,116	+ 1,750	+ .14	50.03
1886	1,355,809	+101,693	+ 8.11	52.91
1887	1,392,909	+ 37,100	+ 2.74	53.17
1888	1,457,264	+ 64,356	+ 4.62	54.43
1889	1,439,701	− 17,563	− 1.21	52.62
1890	1,522,731	+ 83,030	+ 5.77	54.47
1891	1,872,400	+349,669	+22.96	65.69
1892	1,853,370	− 19,030	− 1.02	63.79
1893	1,905,862	+ 52,492	+ 2.83	64.34
1894	2,012,714	+106,852	+ 5.61	66.66
1895	1,949,744	− 62,970	− 3.13	63.36
1896	1,940,086	− 9,658	− .50	61.86
1897	2,070,978	+130,892	+ 6.75	64.80
1898	2,002,902	− 68,076	− 3.29	61.50
1899	2,078,068	+ 75,166	+ 3.75	62.63
1900	2,219,847	+141,779	+ 6.82	65.17
1901	2,372,316	+152,469	+ 6.87	68.44
1902	2,566,108	+193,792	+ 8.17	72.76

[a] According to Willett & Gray.

[b] Tons of 2,240 pounds.

Average import price per pound of sugar imported into the United States. [a]

Year ended June 30—	Raw sugar (not above No. 16 Dutch standard).						Refined sugar. [c]
	Beet.	Cane—				Average for all raw sugar. [b]	
		From Hawaii.	From Porto Rico.	From Cuba.	From other countries		
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1892	2.8	2.8	2.9	3.1	2.7	2.9	3.8
1893	2.9	2.9	3.2	3.3	2.8	3.1	3.9
1894	3.1	2.9	3.2	3.0	2.7	2.9	3.8
1895	2.0	2.7	1.8	2.2	1.9	2.1	2.8
1896	2.3	3.2	2.1	2.2	2.1	2.3	2.9
1897	1.8	3.1	1.8	2.1	1.9	2.0	2.5
1898	1.9	3.3	1.9	2.2	1.9	2.2	2.4
1899	2.1	3.7	2.3	2.5	2.1	2.4	2.7
1900	2.1	4.0	3.4	2.6	2.2	2.5	3.4
1901	2.2	3.9	3.4	2.4	2.2	2.5	2.7
1902	1.6	3.3	3.2	1.8	1.8	2.2	2.4

[a] Based on official returns published by the Bureau of Statistics, Treasury Department. These figures represent the wholesale market prices at the ports of shipment, and do not include the import duty levied in this country nor the cost of transportation to this country.

[b] For 1901 and 1902, as in previous years, including imports from Hawaii and Porto Rico, as well as from foreign countries. The average price of raw sugar imported from foreign countries was 2.3 cents in 1901 and 1.8 cents in 1902.

[c] Including raw sugar above No. 16 Dutch standard.

Average market price of sugar per pound in New York City. [a]

Calendar year.	89° muscovado.	96° centrifugal.	Granulated.
	Cents.	*Cents.*	*Cents.*
1892	2.8	3.3	4.3
1893	3.2	3.7	4.8
1894	2.6	3.2	4.1
1895	2.9	3.3	4.2
1896	3.2	3.6	4.5
1897	3.1	3.6	4.5
1898	3.7	4.2	5.0
1899	3.9	4.4	4.9
1900	4.0	4.6	5.3
1901	3.5	4.0	5.1
1902	3.0	3.5	4.5

[a] According to statistics published by Willett & Gray, of New York City.

Sugar crops [a] *of the world for four years.* [b]

Grand division and country.	1899–1900.	1900–1901.	1901–2.	1902–3.
CANE SUGAR.				
United States:	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Louisiana	147,164	270,338	310,000	280,000
Porto Rico	35,000	80,000	85,000	85,000
Hawaiian Islands	258,521	321,461	317,509	349,000
Cuba	308,543	635,856	850,181	975,000
British West Indies:				
Trinidad, exports	42,210	52,673	51,077	50,000
Barbados, exports	50,000	55,360	43,750	34,000
Jamaica, exports	19,510	17,059	15,843	18,772
Antigua and St. Kitts	15,052	21,579	19,000	18,000
French West Indies:				
Martinique, exports	30,000	39,750	34,942	28,000
Guadeloupe	40,000	39,000	41,000	41,000
Danish West Indies—St. Croix	12,020	13,000	13,000	13,000
Haiti and Santo Domingo	45,000	45,000	45,000	45,000
Lesser Antilles, not named above	8,000	8,000	8,000	8,000
Mexico	78,000	95,000	103,110	115,000
Central America:				
Guatemala	12,000	9,000	10,000	10,000
San Salvador	5,000	5,000	5,000	5,000
Nicaragua	4,000	3,500	4,500	4,500
Costa Rica	4,000	4,000	4,000	4,000

[a] In a number of cases statistics of exports are given, this being indicated.

[b] Statistics of Willett & Gray, except estimate of beet-sugar production in Europe by Licht.

Sugar crops of the world for four years—Continued.

Grand division and country.	1899-1900.	1900-1901.	1901-2.	1902-3.
CANE SUGAR—continued.				
South America:	*Tons.*	*Tons.*	*Tons.*	*Tons.*
British Guiana (Demerara), exports	90,079	84,559	123,967	105,000
Dutch Guiana (Surinam)	9,600	13,000	12,750	13,000
Venezuela	2,000	3,000	3,000	3,000
Peru	125,000	135,000	138,000	140,000
Argentine Republic	91,507	114,252	135,000	130,000
Brazil	322,000	320,000	345,000	187,500
Total in America	1,754,206	2,385,387	2,718,629	2,661,772
Asia:				
British India, exports	10,000	15,000	15,000	15,000
Siam	7,000	7,000	7,000	7,000
Java	721,993	709,928	767,180	842,812
Japan	2,000			
Philippine Islands, exports	62,785	55,400	78,637	80,000
Total in Asia	803,778	787,328	867,767	944,812
Australia and Polynesia:				
Queensland	124,070	92,554	120,858	76,626
New South Wales	15,500	19,000	18,000	18,000
Fiji Islands, exports	31,000	33,000	31,000	35,000
Total in Australia and Polynesia	170,570	144,554	169,858	129,626
Africa:				
Egypt	98,500	94,880	96,200	90,000
Mauritius	157,025	175,267	147,828	135,000
Reunion	35,000	35,000	35,000	35,000
Total in Africa	290,525	305,147	279,028	260,000
Europe—Spain	33,215	28,000	28,000	28,000
Total cane-sugar production	3,052,294	3,650,416	4,063,282	4,024,210
BEET SUGAR.				
Europe (Licht)	5,518,048	6,046,518	6,820,733	5,605,000
United States	72,944	76,859	163,126	195,463
Total beet-sugar production	5,590,992	6,123,377	6,983,859	5,800,463
Grand total cane and beet sugar	8,643,286	9,773,793	11,047,141	9,824,673

SELECTED FARM RESULTS FOR 1902 SHOWING POSSIBILITIES IN BEET GROWING.

To show what it is possible for farmers to accomplish in growing sugar beets, I offer some tables showing the best results obtained by the farmers at the different factories. These do not of course indicate the average results.

AN ILLUSTRATION FROM NEBRASKA.

I have been very much interested during the past year in an experiment at Fremont, Nebr. There is no factory at this place, but there is one at Leavitt, about 11 miles west of Fremont. The business men of the town thoroughly appreciate the advantages growing out of sugar-beet culture in this vicinity. This is the junction point of railroads, which facilitates the delivery of beets to any one of the three factories in Nebraska. For some time it has been the purpose

of those interested in the welfare of the town to eventually establish a beet-sugar factory there. In order to demonstrate to the farmers the practical results of growing sugar beets, a certain number of business men organized the Fremont Sugar-Beet Company. This company rented 150 acres of land, paying therefor $5 per acre, cash rent. This land was planted to beets, and after the crop was delivered to the factory a statement was made for the benefit of those interested in the enterprise, showing the results as follows:

Financial statement of Fremont Sugar-Beet Company for 1902.

Receipts:		
Capital stock		$3,850.00
Beets, 1,749.58 tons, at $4		6,998.33
Beet tops		41.00
Total		10,889.33
Disbursements:		
Labor	$4,352.18	
Seed and freight	448.61	
Land rent	750.80	
Machinery	248.50	
Incidentals and repairs	60.91	
Total		5,861.00
		5,028.33
Deduct capital stock		3,850.00
Net profit		1,178.33

We take great pleasure in presenting to you, as stockholders in the Fremont Sugar-Beet Company, the above statement of the company's financial standing for this year; and we hope that the profit therein shown will in a measure compensate those who have been faithful and persistent in fostering this young but beneficial industry.

We also hope that the flattering results of this year's work will quiet the fears of any who might still be skeptical as to this industry being made a success in our locality.

We may therefore look for more uniform results in coming years than we have had in the past.

And last, but not least, the experience gained in the past will prove of great service in the future.

A. S. GRIGEREIT,
W. A. CARROLL,
FRANK HAMMOND,
Committee.

One interesting feature about the above report is the fact that everything done was hired. The parties interested in this company were business men. A man thoroughly acquainted with growing beets was employed to superintend the job.

The above statement is a remarkable showing of the practical results of beet-sugar growing from an investment standpoint. This company after paying all expenses had a full equipment of necessary

farm implements on hand valued at $248, less a fair allowance for wear and tear. In addition, it had a balance in its treasury of $215.82 after declaring a dividend of 25 per cent.

The following deductions are made by myself from the data contained in the report of the company:

The average yield of these 150 acres was 11.67 tons of beets per acre. The gross receipts were $46.68 per acre. The cost of producing the beets, including the rent of the land, was $37.58 per acre. The net returns from the crop of beets were $9.10 per acre. If no rent had been paid for the land, the net returns would have been $14.10 per acre.

An idea of the comparative profitableness of the beet-sugar crop can be obtained by comparing the above figures of net returns with with the average gross returns obtained by farmers who raise grain. The crop statistics for 1902 collected by the United States Department of Agriculture show that the average gross values per acre of the principal cereal crops for the entire country were as follows: Corn, $10.81; wheat, $9.14; oats, $10.60; and barley, $13.28.

It will be noticed that the tonnage of beets produced at Fremont is not remarkably large, nor is the cost of production as low as the estimated average for sugar-beet crops. Yet it may well be doubted if these same parties could have found any other investment from which they could have gotten larger legitimate dividends than they secured from growing these sugar beets.

The important thing, and the thing that is absolutely necessary to the success of a sugar factory, is beets. There is hardly a factory in the country to-day that has been able to purchase a sufficient supply of beets to meet the requirements of a full campaign. This report of the Fremont Sugar-Beet Company should stimulate business men as well as farmers to undertake the growing of sugar beets not merely as a profitable investment, but as a means of sustaining an industry which does so much for the prosperity of the whole community.

SOME FARM RESULTS IN MINNESOTA FOR 1902.

During the campaign of the Minnesota Sugar Company last fall I called at the factory and was shown by the manager, Mr. Fink, some of the individual accounts with the farmers.

These accounts showed (1) the gross weight of beets, (2) the amount of tare, (3) net weight of the beets, (4) gross amount and value of total crop, (5) a statement of freight showing the factory's share and the farmer's share, (6) the charges of the factory for the use of different implements, (7) total amount of seed used, (8) total amount deducted for seed, and (9) the net amount to be forwarded to the farmer.

It occurred to me that a reproduction of a limited number of these

accounts might be quite interesting to those investigating the results of sugar-beet growing. Mr. Fink offered to furnish me copies of as many of them as I desired, and I asked for 25 of his best. From these I have compiled the table below. It should be kept in mind that these are not average results, but the best results obtained at that factory during the campaign of 1902, the object being to show the possibilities of growing sugar beets under ordinary circumstances.

Accounts of 25 successful beet growers in Minnesota in 1902.

Grower's name and address.	Number of acres.	Gross weight of beets.	Tare.	Net weight of beets.		Gross value.	Freight charges.		Rent of implements.	Seed used.		Net amount of check.
				Pounds.	Tons.		Factory's share.	Farmer's share.		Amount.	Value.	
		Lbs.	*P. ct.*							*Lbs.*		
P. Fortin, Hamel	2	83,060	8	77,165	38.53	$175.86	$12.25	$7.75	$1.00	36	$5.40	$161.71
T. Schwalbe, Waconia	5	156,482	10	140,842	70.42	316.90	27.37	11.75	.....	72	9.45	295.70
D. Stockmann, Plato	2	72,055	7½	66,395	33.19	149.37	12.60	9.33	1.25	36	5.40	133.30
N. N. Waylander, Grove City	3	124,650	8½	113,615	56.81	255.63	21.81	25.28	2.00	108	16.20	211.55
Nels. M. Okeson, Grove City	2	76,410	7	71,155	35.58	160.10	13.37	17.17	1.50	36	5.40	136.03
Geo. Dimler, Chanhassen	2	92,500	6	86,855	43.43	195.49	16.18	6.95	1.00	36	5.40	182.14
O. E. Stromberg, Buffalo	2	74,860	6	70,370	35.19	158.33	13.10	12.79	1.00	36	5.40	139.14
W. Luehring, Hamburg	3	176,210	9½	159,680	19.84	359.27	30.83	22.02	2.25	90	13.50	321.50
J. Martin, Owatonna	1	38,150	6½	35,670	17.84	80.26	6.68	6.67	.75	18	2.70	70.14
W. Herman, Heidelberg	1	45,700	7	42,500	21.25	95.62	8.00	5.71	.75	18	2.70	86.46
Aug. Henschke, Arlington	1	36,220	10	32,600	16.30	73.35	6.34	6.33	.75	18	2.70	63.57
F. Wickenhauser, jr., Cologne	1	41,450	5	39,380	19.69	88.60	7.25	5.18	.....	18	2.70	79.47
Thos. Kasperek, New Prague	2	72,900	7½	67,435	33.72	151.73	12.76	9.11	1.50	36	5.40	135.72
Mrs. Sebilla Van Horrik, Glencoe	3	96,390	7½	88,855	44.33	199.92	16.87	12.05	2.00	54	8.10	177.77
Aug. Cohrs, Glencoe	1½	56,240	7	52,305	26.15	117.67	9.84	7.03	.75	27	4.05	105.84
Daniel Danielson, Dassel	2	87,865	6½	81,935	40.97	184.35	15.37	19.77	1.50	36	5.40	156.90
John Almquist, Dassel	1	42,290	5½	39,850	19.93	89.66	7.40	9.51	.75	24	3.60	75.80
Carl Ponath, Young America	2	80,400	10	72,360	36.18	162.81	14.07	10.05	1.50	36	5.40	145.86
John Dietel, Young America	2	67,630	9½	61,290	30.64	137.89	11.83	8.46	1.50	36	5.40	122.58
Frank Treka, Montgomery	2	88,970	.....	80,270	40.14	180.60	15.57	11.12	1.25	36	5.40	162.83
Frank Kukachaka, Montgomery	3	126,180	10	113,565	56.78	255.52	22.09	15.76	2.00	64	9.60	228.16
Thos. Choudeck, Montgomery	2	107,810	8½	98,785	49.39	222.27	18.87	13.48	1.50	84	8.10	199.19
Jacob Ectek, Montgomery	1½	56,630	8	52,100	26.05	117.22	9.91	7.08	.75	21	3.15	106.24
Johann Melchert, Waconia	1½	48,970	10	44,073	22.04	99.16	8.57	3.67	.60	27	4.05	90.84
Geo. Buaernschmitt, Waconia	2	77,960	9½	70,410	35.21	158.41	13.64	5.85	1.50	36	5.40	145.66

This table reveals several interesting things, among others that the amount of tare or dirt adhering to beets as ordinarily delivered to the factory runs from about 5 to 10 per cent. The tare in a factory depends

largely upon the character and conditions of the soil. Certain kinds of clay will adhere more largely than will sandy soil. Some soil will adhere to the beets more if the ground be wet and muddy than if it be dry. The percentage of tare shown in this table is probably a fair average for the factories in all sections, although in extreme cases it runs up as high as 25 per cent.

The average cost of producing an acre of sugar beets at this factory is about $30. From this table anyone can easily calculate the net returns per acre which the 25 farmers secured. They are as follows:

1	$57.93	14	$36.64
2	33.38	15	48.44
3	44.68	16	62.17
4	55.21	17	59.66
5	50.50	18	51.40
6	67.74	19	38.94
7	49.16	20	60.30
8	89.75	21	55.17
9	50.26	22	81.13
10	65.62	23	63.77
11	43.35	24	36.10
12	58.60	25	49.20
13	45.86		

SOME FARM RESULTS IN COLORADO IN 1902.

Below I give a table furnished by the management of the American Beet Sugar Company to a Colorado paper, giving a detailed account of the farm results of all the producers growing sugar beets for the factory at Rockyford, Colo. In this table are given the gross amounts received by 22 farmers whose receipts were more than $100 per acre. There is also given the number of farmers receiving from $40 to $50, from $50 to $60, from $60 to $70, from $70 to $80, from $80 to $90, and from $90 to $100 per acre, respectively. All beets worked at this factory are grown by the aid of irrigation.

The following is clipped from the Independent, Littleton, Colo.:

The American Beet Sugar Company furnishes us the following figures showing the results of the campaign just closed. The figures which show up the agricultural resources of the valley to the best advantage are those which give the names and amounts of cash received by the most successful growers. The table below and the synopsis following it make a showing for farming profits hard to beat, either in the East or in the West:

Total quantity of beets received	tons..	113,361
Average sugar content of beets received	per cent..	17.19
Average price paid for beets received		$5.00
Sugar made, including osmose	pounds..	29,500,000

The following parties received for beets over $100 per acre:

A. J. Gillock, Deerfield, Kans	$133.06
C. T. Kouns, Rockyford, Colo	129.48
E. F. Kelso, Rockyford, Colo	126.75

J. L. Bennett, Rockyford, Colo	$123.62
Henry Entz, Lakin, Kans	119.60
J. C. Whittaker, Rockyford, Colo	114.98
William Morrison, La Junta, Colo	113.57
Francis McCormick, Rockyford, Colo	112.62
L. C. Swink, Rockyford, Colo	111.10
William Crabb, Rockyford, Colo	110.24
J. W. Belew, Rockyford, Colo	109.57
James Piper, Rockyford, Colo	109.00
William Waters, La Junta, Colo	108.80
L. M. Kell, Deerfield, Kans	105.24
T. A. Eavis, Manzanola, Colo	104.81
Carl Coerber, Lakin, Kans	103.90
C. J. Cover, Lakin, Kans	103.40
J. P. Mulloney, Rockyford, Colo	102.30
J. A. Keithly, Rockyford, Colo	102.20
William B. Ebbart, Rockyford, Colo	101.20
A. P. Kouns, Rockyford, Colo	100.80
Joseph Gill, Powers, Colo	100.33

Number of growers receiving—

Over $100 per acre	22
From $90 to $100 per acre	17
From $80 to $90 per acre	49
From $70 to $80 per acre	61
From $60 to $70 per acre	103
From $50 to $60 per acre	143
From $40 to $50 per acre	187

SOME FARM RESULTS IN MICHIGAN IN 1902.

The following table shows the results obtained by 15 of the most successful farmers at Lansing, Mich. It is given for the same purpose as the similar statements which precede it, viz., to show the possibilities:

Results achieved by 15 beet growers near Lansing, Mich.

Name and address of grower.	Area harvested.	Average yield per acre.	Weight of beets harvested free from dirt.		Cash receipts for crop.[a]	Cash receipts per acre.
			Pounds.	Tons.		
	Acres.	*Tons.*				
C. C. Allen, Lansing, No. 5	10	10.19	203,941	101.97	$530.14	$53.01
Otto Felzke, Delta	4	10.20	83,662	41.83	209.21	52.30
W. J. Waller, Bath	2	21.08	84,328	42.16	213.06	106.53
Jas. Cortwright, N. Lansing	3	13.60	81,627	40.81	106.05	85.35
Clark Smith, Grand Ledge	2	15.66	62,676	31.33	167.16	83.58
G. Schray, Lansing, No. 4	16	11.61	371,586	185.79	952.02	59.50
H. J. Henderson, Lansing, No. 1	4	12.27	98,216	49.10	260.47	66.62
E. P. Rowe, Mason	6	16.05	192,643	96.32	453.70	75.62
W. R. Quantrell, Charlotte	10	10.96	219,354	109.67	522.29	52.23
J. W. Wheeler, Portland	2	12.37	49,517	24.75	115.26	57.63
Noah Porter, Williamston	2	10.68	42,728	21.36	105.07	52.53
Lewis Dunn, Shaftsbury	2	14.22	56,913	28.45	123.40	61.70
G. R. and L. E. Ling, Webberville	4	13.80	110,409	55.20	270.91	67.73
W. J. Davis, Bismarck	2	17.77	71,098	35.54	164.51	82.25
E. H. Hume, Lansing, No. 1	20	9.89	394,945	197.47	1,011.41	50.57

[a] This column shows the amounts which the farmers received for the beets after charges for seed and transportation had been deducted.

AGRICULTURAL CONDITIONS, FARM RESULTS, AND RELATIONS BETWEEN THE FACTORIES AND THE FARMERS.

In order to bring out some interesting information touching farm conditions and results, I wrote to each of the sugar factories of the United States, asking for a report from the agriculturist as to the season, results of beet growing, different factory relations with the farmer, kinds of implements and seed used, disposition of pulp, etc.

As it appeared from several of these communications that the manufacturing companies preferred that they be treated as more or less confidential, I withhold the names of the factories, simply indicating the locality of each, and submitting the information for what it is worth, believing the reports contain much valuable information.

The letter of inquiry sent out is given first, and is followed by the replies:

DES MOINES, IOWA, *February 2, 1902.*

DEAR SIR: In order to present intelligently to the Government, and through it to the people of the United States, the facts and conditions underlying the progress of the beet-sugar industry, I feel the necessity of furnishing the actual results, conditions, and experiences at the factories themselves.

Below I give a list of inquiries, which I presume could be answered best by the agriculturist. Will you not kindly hand this letter over to the proper person, with a request that a report for 1902 be furnished me along the lines indicated below, numbering each reply to correspond with the topic.

(1) The general favorable or unfavorable conditions of the season (1902) at different times, with effect.
(2) Price paid for beets.
(3) Number of acres planted.
(4) Tons of beets worked at factory.
(5) Methods of determining tare.
(6) Your system of dumps and cost of unloading per ton.
(7) Kinds of harvesters, and experience with them.
(8) Average yield of beets per acre.
(9) Values of lands and rents.
(10) Cost of producing beets.
(11) Labor, kind, cost, and supply.
(12) Seed, kind and cost to farmer; amount used per acre; home grown or foreign.
(13) How many times are beets hoed, cultivated, and irrigated?
(14) Freight charges on beets.
(15) Number of contracting farmers.
(16) Do you produce sugar-beet seed? If so, how much?
(17) Pulp feeding, price of pulp, and its popularity.
(18) Amount of pulp produced and disposition made of it.
(19) Stock feeding, dairying, etc., in your vicinity.
(20) Rotation of crops.
(21) Kind of ground, soil, and preceding crop.

I have asked the Department to forward you my last report.

Respectfully,

C. F. SAYLOR,
Special Agent in Charge of Sugar Investigations.

REPORT FROM A MICHIGAN FACTORY.

(1) Our season the past year was wet from start to finish. The seed never sprouted on some of the patches on account of being under water, and many beets were never pulled because the ground was too wet to get on and work. This, of course, decreased the yield to a great extent. Take it all in all, the season was a very unfavorable one for a good crop.

(2) We paid the farmers the regulation Michigan price for beets, $4.50 per ton for 12 per cent beets, and 33⅓ cents added or deducted for each per cent above or below 12 per cent. The highest price paid was $6.57 per ton, the average price $5.13, and the lowest $3.14.

(3) We had nearly 4,700 acres on our books, some of which, however, was never planted on account of the wet weather.

(4) Our net washed beets amounted to 27,242 tons for the season, the average tare being 11.6 per cent.

(5) In determining the tare, we use the washing by water method. Frozen beets, or beets with frozen soil on them, are washed in warm water, and afterwards dried, topped, and then weighed back. The topping is done with a knife, topping each beet singly.

(6) We have no regular system of dumps, all beets being unloaded by hand, both from cars and wagons. For unloading the beets received in cars we pay 8 cents per ton. This work goes to one man under contract.

(7) The only harvester that is used here is a patented beet puller, which works very satisfactorily as far as it goes. All it does, however, is to lift the beets. They are then topped on the field by hand.

(8) The beets averaged no more than 6 to 7 tons per acre, being just about one-half a crop.

(9) The value of land and the rent of the same are very hard to get at. Prices have, of course, risen very much since the industry started here. Some exceptional pieces of land are renting as high as $20 per acre, but the usual rent is somewhat lower, ranging from $5 to $15 per acre.

(10) We usually figure the cost of producing at from $15 to $30 per acre, dependent, of course, upon the nature of the land, nearness to the city, etc.

(11) The labor in our vicinity is entirely domestic. Up to this time we have imported none. For the past two or three years it has been very hard to get, so many of the laborers have been flocking to the towns, preferring, it seems, factory work. Last year some of the farmers paid as high as $1.25 to $1.50 per day and board. The usual price, however, is from $20 to $40 per month.

(12) We used last year only two kinds of seed, Hoerning's Improved Kleinwanzlebener and R. & G.'s Original Kleinwanzlebener. This costs the farmers 15 cents per pound, which amount we deduct from their first delivery of beets in the fall. They use from 10 to 16 pounds per acre, depending upon the soil, the heavy clay soils seeming to need more than the sandy soils. We use no domestic seed at all.

(13) We use no irrigation whatever.

(14) Freight charges: From 1 to 25 miles, 30 cents per ton; from 25 to 50 miles, 50 cents per ton; from 50 to 60 miles, 60 cents per ton; from 60 to 75 miles, 70 cents per ton. The above are the rates when the beets are delivered by one road. When the beets are shipped over two roads, the rates are nearly doubled for the same distance.

(15) We had on our books this year 1,833 contractors.

(16) We produce no sugar-beet seed.

(17) Pulp feeding has not been very popular in this immediate vicinity, especially the past season, as the nice late fall gave the farmers lots of grazing, and they did not care to haul pulp while they could keep their cattle on grass. After snow came there seemed to be no trouble in getting the farmers to take it. The beet raisers got

it for hauling, and those living at a distance got it for the freight charges, which are the same as they are on beets.

(18) We produced last year about 23,000 tons of wet pulp. Of this we shipped about one-tenth by rail, the farmers hauled away about one-third, and the rest was "turned under" on adjoining vacant property.

(19) There is very little stock raised here, but considerable dairying.

REPORT FROM ANOTHER MICHIGAN FACTORY.

(1) During the time for preparing the land, planting, and germination of the seed, the season was very favorable, but during the cultivating and harvesting it was very unfavorable on account of excessive rains, making a low tonnage on level lands that were not thoroughly underdrained by causing the beets to be small. The higher and more rolling grounds that were surface-drained gave the best results.

(2) The average price of beets was $5.40.

(3) The number of acres planted was 5,500.

(4) The number of tons of beets worked at the factory was 38,499.

(5) In determining tare, we select 20 pounds of beets, wash, trim, and weigh again.

(6) We unload by hand, at a cost of 7 cents per ton.

(7) Kind of harvester used: Patented beet pullers and a side-lifting plow. We believe the plow to be the best.

(8) The average yield of beets was 7½ tons per acre.

(9) Value of lands, $40 to $75 per acre; rent, $3 to $7 per acre.

(10) The estimated cost of producing beets was $35 per acre, including rent of land.

(11) Our labor is mostly American, some German, Polack, and Assyrian. Wages are from $1 to $1.50 per day. The supply of labor is good.

(12) We use foreign-grown German seed, mostly Kleinwanzlebener, costing 15 cents per pound. We use 15 pounds to the acre.

(13) Beets are hoed not more than once, cultivated 4 to 6 times, and irrigated when the Lord pleases.

(14) Freight charges on beets: For a haul of 25 miles or less, 40 cents per ton; for 25 to 45 miles, 50 cents; 45 to 60 miles; 60 cents; for 60 to 80 miles, 70 cents.

(15) Number of contract farmers, 900.

(16) We do not attempt to produce our own sugar-beet seed.

(17) Pulp for feeding is free to our contracting farmers; the balance we sell at 10 cents per ton. It is growing in popularity.

(18) The amount of pulp produced we estimated at 40,000 tons. All that is not hauled away by the farmers is sold to one party.

(19) There is more dairying than stock feeding in this vicinity.

(20) Rotation of crops is not generally practiced here.

(21) All kinds of ground are used, from light sand to muck. The preceding crop varies.

REPORT FROM A THIRD MICHIGAN FACTORY.

(1) The general conditions for the sugar-beet industry in Michigan are good. We had an excellent season in 1898. In 1899 we had too much rain at first, and then at the end of the season extremely dry weather. In 1900 and 1901 we had good seasons, that of 1900 being excellent. The season of 1902 was extremely unfavorable. The whole summer was nothing else than a rainy season, and the greater part of the land was flooded most of the time. The farmers in general seem to be satisfied. The good farmers, who exactly follow our advice in rotating grain, clover, grain, and beets, and who keep the necessary amount of live stock, are obtaining excellent results, and are making money as fast as the farmers in the old beet districts of Germany have done.

(2) The price paid for beets is $4.50 for 12 per cent beets, and 33⅓ cents for each additional per cent. The average price paid during the season of 1901 was $5.55, and for the season of 1902, $5.20 per ton.

(3) The number of acres planted in 1902 was 10,551.

(4) We worked 64,063 tons of beets, automatic scale weight.

(5) In determining tare, the beets are brushed with wire brushes, being weighed and reweighed by a small automatic scale.

(6) We unload all beets with forks, and do not use dumps. It costs us about 8 cents per ton.

(7) We use the simple beet puller. We lift the beets and top them by hand, and no harvesters are used.

(8) Our average yield per acre in 1901 was 9½ tons, and in 1902 6½ tons. The highest yield was 22 tons per acre.

(9) The value of land is from $40 to $100 per acre. Rent is from $4 to $10 per acre.

(10) Cost of producing beets is from $30 to $45 per acre, according to how well the land has been farmed during previous years, whether or not it is full of weeds, whether it is properly drained, and the stock of plant food it contains.

(11) The labor we use is picked up all around the cities and country generally. The last two years we introduced some German labor from Nebraska and other States, which has proven satisfactory to our farmers. They work together in families, and the farmers furnish them houses to live in. The cost of such labor is $20 per acre, and they do all the hand work which the beet crop entails. Other labor, if we engage it by the day, costs from $1 to $1.50.

(12) The kind of seed used around this factory very successfully for the last four years is Hoerning's Improved Kleinwanzlebener Special Elite, imported from the old beet-seed district in the Harz Mountains, Germany. We charge the farmers 15 cents per pound, and recommend them to plant from 15 to 20 pounds per acre.

(13) We recommend hoeing the beets twice after thinning, and three times will be still better, and is the practice of a great many farmers. We cultivate the beets generally once every week or ten days until the leaves cover the ground and we can not get into the field to cultivate.

(14) Freight charges on beets are 40 cents per ton for 25 miles or under; 50 cents for 25 to 40 miles; 60 cents for 40 to 60 miles; 70 cents for 60 to 80 miles; 80 cents for 80 to 100 miles.

(15) The number of contracting farmers in 1900 was 1,461, and in 1902, 2,270.

(16) We produced a small amount of home-grown seed in the last two years, not to exceed 3 tons. It was grown from the seed we imported, and proved to be just about as good.

(17) Pulp feeding meets with success. The number of farmers who take pulp increases each year. They get the pulp free of charge at our factory.

(18) The balance of the pulp which the farmers do not take is washed into a large settling basin where it is drained, and is let lie there.

(19) Stock feeding and dairying have increased a great deal in this vicinity since the factory started.

(20) The most common rotation of crops among the farmers here is beets, grain, corn, and beets again; or grain, corn, clover, and beets. We recommend beets, summer grain with which clover is sown, clover stubble manured and either put in beets or put in winter grain and followed by beets the next year.

(21) The kind of soil in this vicinity is a first-class sugar-beet soil, exactly as in the old beet-sugar districts in Germany around Magdeburg, Halle, and some other places. The farmers are finding out that they are raising excellent grain and clover crops after beets.

REPORT FROM A NEBRASKA FACTORY.

(1) The general conditions during the season of 1902 were rather unfavorable on the whole. During the planting season the conditions were favorable enough, but later the precipitation of moisture was at intervals too heavy. We had 6.24 inches rainfall in June and 7.16 inches in July, and while this was not too much, if properly distributed, yet coming as it did pretty much at one time, it delayed work and made it more expensive to clean fields, with resulting damage to the crop. We had a wet fall, from September 15 well up into December, the precipitation being 3.53 inches in the latter part of September, 2.51 inches in October, 1.48 inches in November, and 1.29 inches in December, not counting snows. The extreme wet condition of the soil not only caused leaf spot to develop and damage the crop, but it made harvesting difficult and expensive on account of bad roads and the muddy condition of the ground. At the same time the moisture kept the crop growing late, prevented natural ripening, and the number of cloudy days seriously affected the storage of sugar by the beets.

(2) We paid a minimum price of $4 per ton for beets testing 14 per cent or less, and 25 cents additional for each per cent of sugar above 14 (fractions in proportion), the factory paying the freight rate, making our beets cost us $4.53 per ton.

(3) The area in beets was 3,700 acres.

(4) The total production of beets was 36,884 tons.

(5) To determine the tare we take a sample of 30 pounds from each wagon, and three samples from different places in each car, which we average. The sample baskets are filled with a fork, just as though they were going to be thrown in the storage bin.

(6) We do not use dumps. Our sheds are arranged to unload with nets, but so far the farmers have not equipped themselves to have their beets unloaded in this way.

(7) We have not used anything in the shape of a harvester. We just plow them out with beet plow and top by hand.

(8) The average yield was 9.97 tons per acre.

(9) The price of land is $65 to $70 per acre; the rent $3 to $5 per acre.

(10) The cost of growing beets is about $35 per acre where all the work is hired, though farmers who have help of their own claim they raise them much cheaper.

(11) We employed day labor. Men cost $1.50 per day, women $1 to $1.25, and boys and girls from 50 cents to $1 per day. Labor was very scarce during the fall.

(12) We used various kinds of seed, mostly Original Kleinwanzlebener, Pioneer Kleinwanzlebener, Dippe Kleinwanzlebener, and Dippe Zehringen.

(13) Beets were all hoed once and some of the fields twice, the last hoeing being to clean out weeds only. They were cultivated four, five, and six times. We have no irrigation.

(14) Our freight rate was 50 cents for distance of 150 miles on a single line of road, and double that for longer distances.

(15) We had 262 contractors.

(16) One of our contractors raised about half a ton of seed, which gave good results, a little better he thought than those obtained from imported seed.

(17) The pulp has been fed to 4,500 steers. We furnished the pulp all to a cattle-feeding company without charge, and they consider it a very valuable food.

(18) We have no way of telling the amount of pulp produced, probably about 19,000 or 20,000 tons. Part has been fed, and the balance is stored in a silo and is being fed now.

(19) There is very little dairying here, though it is now starting up some, and we already have applications for pulp from dairymen for next year.

(20) The land being new out here, rotation of crops is not carefully practiced yet. Some beets are planted on a two-year rotation with corn. Some adopt a three-year rotation, corn followed by oats or wheat and then beets.

(21) We have a variety of soils—clay loam, sandy loam, and heavy gumbo—all giving good results. Beets here are planted after corn, wheat, or oats.

REPORT FROM A UTAH FACTORY.

(1) The weather early in the season was favorable for rapid growth and had much to do with the good stand that was generally secured. The fall weather was dry and sunny, favoring the harvesting and preserving the beets from great deterioration. The rapid growth during the spring and early summer caused the thinning season to come on quickly, and many growers were not equal to the task; hence the thinning and weeding became rather in arrears. The midsummer weather was hot and dry, so that something like one-third of the crop was not irrigated at all. This occurred after a rather rainy period in the spring, which caused the soil to become harder than usual, and many failed to begin deep cultivation early enough to keep the ground loosened properly.

(2) Price paid for beets, $4.50 per ton at the plant.

(3) Number acres planted, 4,238.

(4) Quantity of beets paid for, 42,472 tons.

(5) Our average tare was 3.02 per cent. We have very little trouble with farmers regarding tare, and in every instance when their loads have been tared by selecting a bushel and weighing in the gross and then cleaning and topping properly and reweighing, they have been content to have the tare estimated as in the usual way. The tare is very moderate, as you will perceive, but we have no "chrono" at the plant to check the weight of beets received and worked.

(6) Beets are unloaded by hand into sheds from wagon and car.

(7) For harvesters there are used common plows with mold board removed, subsoil plows, and regular beet pullers. The latter are better when land is hard.

(8) Average yield from acres harvested, 10.45 tons per acre.

(9) Average value of land with water right and improvements, $100 per acre. Rents average about $10 per acre and run as high as $20.

(10) Reasonable cost of raising an acre of beets based on actual accounts received from reliable growers with good crops, $36 per acre including all but rental of land and water right. Items run as follows: Plowing, $2; preparing, $2.50; planting, $2.75; thinning and hoeing, $5; five cultivations, $2.50; irrigating, $1.50; harvesting 16 tons beets, $19.75. The above does not include fertilizers, and this is not a locality where manuring or any form of fertilizing other than that from the growth of alfalfa is carried on systematically.

(11) The labor is principally local, with some few Japanese who are excellent workers. The cost of common labor on the farm is $1.25 per day; beet thinners get 75 cents and Japanese $1 per day. The supply of cheap labor is becoming scarce and the cost is gradually increasing.

(12) The seed costs 15 cents per pound. It is obtained from Germany, and 17 pounds per acre are used.

(13) One hoeing is usually all that is given. A second is necessary on land that is somewhat foul with weeds; if this is given, the cost per acre as stated above will have to be increased to $40 per acre exclusive of rent and water right. The beets are irrigated twice or three times when thoroughly done, but there are few of our growers who can actually water all their fields so abundantly as this.

(14) Freight charges for the most part run 35 cents per ton, of which the company pays 10 cents and unloads from the car to the sheds, so that most of the beets net the grower $4.25 per ton on cars.

(15) There were 967 growers in 1902.

(16) No seed is grown at this plant.

(17) Pulp is very popular as feed, some paying as high as 90 cents per ton from the silo, but this season (1903) the pulp will be sold by the company and the growers can secure approximately one-half the beet tonnage they deliver in pulp at 50 cents per ton, while the remainder will be sold to feeders at best prices possible.

(18) We calculate that the pulp from silo will, after fermentation and the drainage that occurs, amount to about one-half the weight of the beets cut. Most of it is used from the silo, hence this weight is not far from correct.

(19) Stock feeding is carried on at the plant by a number of stockmen; and, likewise, the sheep growers are wintering largely in the vicinity and feeding pulp heavily. Dairying is increasing, and while the individual dairymen have but small dairies, yet they use pulp where located within reasonable hauling distance, and creameries are being added constantly at various points in the vicinity of the sugar plant. There is no trouble in disposing of the pulp.

(20) Rotation of crops is not carried on as efficiently as it should be, for the farming had been very slack here previous to the establishment of the sugar and canning plants; and, while there were a number of small farmers in the country, they were merely existing by raising a part of what they consumed and acting as laborers to secure a little ready money; and taxes were the extreme hardship of their lives. Small farms in the East would not have paid for the burial of the owners, to say nothing of furnishing a living if worked as the majority of such farms here were worked previous to the introduction of the sugar industry. There is much improvement needed yet by the small farmer before the full measure of his success is reached. This is a most favorable locality for markets, and when the farmers become so interested as to carry on rotation of crops and fertilize and irrigate intelligently, and when they realize the value of early and deep cultivation to protect against drought, they will reach a degree of prosperity that will be wholesome to say the least.

(21) The soil varies from light sand to sandy loam with small tracts of gravel near the mountains, and heavier soil, containing considerable alkali, on the level between the mountains and the Great Salt Lake. There are benches of higher lands running from the base of the mountains toward the lake flats, and these furnish the better grades of soil for the beet growing and will subirrigate in a satisfactory manner. In the Government investigations this soil has been classed with the Fresno sand and the Fresno sandy loam. There is more attempt to grow beets after alfalfa than at first; but other than this there is little done toward systematic rotation of crops; but beets can be grown profitably on this land by manuring lightly each season, or heavier each alternate season, as the land is provided with the mineral salts in abundance, and, when these become properly disintegrated and a supply of nitrogen is furnished, there is a constancy about its productiveness that is pleasing.

REPORT FROM A SECOND UTAH FACTORY.

(1) The season was rather late in opening, but after the weather became settled it was favorable to rapid growth and to a good stand, an excellent stand being generally secured. Late planting and rapid growing weather prevented proper thinning.

(2) The price paid for beets was $4.50 per ton at the plant, the minimum for quality being 14 per cent of sugar and a purity coefficient of 80.

(3) The number of acres planted was 5,498; the number harvested, 4,672.

(4) The gross weight of beets received was 38,129 tons; the net weight, or the amount paid for, was 36,942 tons.

(5) The tare was 1,187 tons, being 3½ per cent of the net weight. Tare is estimated generally, but tests are made by sampling and weighing, then cleaning with brush, topping properly, and reweighing.

(6) We have an arrangement for dumping beets from the cars into the silo, but no account of cost was kept. Wagons are dumped or unloaded by hand.

(7) Beets are harvested by means of common plows and beet pullers. The latter work satisfactorily.

(8) The average yield of beets was 7.9 tons per acre.

(9) Land values are about $75 per acre, and rents approximately $7.50 per acre.

(10) The cost of raising beets is about $36 per acre, exclusive of rent for land and water and without fertilizer. The costs of operations in detail per acre are about as follows: Plowing land, $2; getting land ready for planting, $2.50; planting, $2.75; thinning and hoeing, $5; cultivating five times, $2.50; irrigating, $1.50; harvesting (with yield of 16 tons per acre), $19.75.

(11) Labor is mostly local, and costs from 75 cents to $1.25 per day for farm work. Very little outside labor is employed. Some effort has been made to get Indians to work in the beet fields, but no reports of results are available at present.

(12) The seed used is from Germany, and costs the growers 15 cents per pound. About 15 pounds per acre are used.

(13) The beets are usually hoed once when thinning, and very little hoeing is done thereafter. The best farmers cultivate five times, but in many cases two cultivations are all the beets get. They are irrigated two or three times when water can be secured.

(14) Freight charges are 35 cents per ton, and this expense is borne entirely by the growers.

(15) We had 1,093 contractors in 1902.

(16) No seed is grown by this company or by anyone else for use in this section.

(17), (18), and (19) Pulp is coming into favor as a stock food for cattle and sheep. There is little dairying here. The pulp has been sold to a feeding company, but next year (1903) it will be sold to the beet growers at 50 cents per ton to the extent of one-half the weight of beets they deliver, the pulp to be removed not later than March 31 of the following season. The surplus pulp will be sold to feeders on the best terms possible. The pulp, after being siloed and fermented, amounts to about one-half the weight of the beets.

(20) No particular system of rotation is followed. The main crops are wheat and alfalfa. Some oats are grown.

(21) The soil is principally clay loam, with occasional ridges of sandy land. The main body of tillable land lies slightly sloping to the center of the valley, and the alkali is found to collect in the lower sections.

The main requirements in regard to the field conditions would seem to be the necessity for some increased supply of cheap labor, and then a scheme of careful superintendence of the growers during the season. Seeding must be done promptly, for the season is later than in other localities; and the thinning must be closely watched, for the inclination has been to leave plants too close together. The value of deep mulch and the use of the cultivator must be constantly dwelt upon, for there is too much dependence placed upon irrigation and a disposition to cease work as soon as dry weather prevails and water is scant in the canals. There is much disappointment met with, also, where the supply of water is abundant and its use is continued without cultivating afterwards, for in this case there is a magnificent growth of leaves, which indicate a splendid condition of the crop, but upon harvesting the roots are small, and the condition is similar to that of grain that runs largely to straw.

REPORT FROM AN OREGON FACTORY.

(1) There was nothing unusual about the early weather, but, as usual, it was rather cold and dry for early growth.

(2) We paid $4.50 per ton for all beets running 12 per cent sugar and having purity of 80 or over, beets to be delivered at the factory. The quality of the beets is high.

(3) The acreage harvested was 2,600 acres. The acreage is increasing.

(4) We worked 17,686 tons of beets.

(5) The tare amounted to 5⅛ per cent of the weight of the beets paid for.

(6) Beets are unloaded by hand from cars and wagons to sheds.

(7) Plows and beet pullers are used in harvesting.

(8) The average yield from acres harvested was 6.8 tons.

(9) Dry land in sections where beets are grown runs about $60 per acre. The rent is about 10 per cent of the value of the land. Such land is only worth one-half as much as irrigated land for beets and less than that for many other purposes.

(10) The cost of producing beets is about $25 per acre for dry land not irrigated or fertilized, and not counting interest on investment.

(11) The labor is mostly local, though in a few instances the growers have brought in foreigners from Europe. But this has not been done to any considerable extent, and the main difficulty as yet is to secure a supply of cheap labor.

(12) The seed used is imported from Germany.

(13) The beets are mostly grown without irrigation. Generally the acreage is so large that but little work is done on the crop after thinning, which is one reason why the acreage cost of production is low. The slack methods of cultivation prevailing in western sections can not be charged up to the sugar-beet industry, inasmuch as wheat growing in its crudest form was the highest cultivation known prior to the introduction of the beet crop. The value of early and deep cultivation is not yet appreciated.

(14) Freight rates are 50 cents per ton and are paid by the grower.

(15) There were 115 growers, averaging 26.1 acres each.

(16) No seed is grown here.

(18) The pulp produced, when drained and fermented, amounts to about 50 per cent of the weight of the beets. The pulp is all sold to one party for a definite sum.

(19) Stock feeding is practiced considerably, but there is very little dairying, there being a scarcity of small, thrifty farmers.

(20) There is very little rotation of crops practiced.

(21) In one part of this section the soil is sand and clay mixed; in the other and higher part it is mostly sandy loam to light sand.

REPORT FROM A MINNESOTA FACTORY.

(2) The average price paid for beets was $4.92 per ton.

(3) Number of acres planted to beets, 3,800.

(4) Number of tons of beets worked, 32,000.

(5) The methods of tare employed by us are those employed by most factories. We draw samples from each wagon or carload from the top, from the center, and from the bottom, fill a basket containing net 50 pounds, subject these beets to a washing and cleaning process, and weigh them again after they have been partly dried, counting about 1 per cent for moisture absorbed.

(7) As to kind of harvesters used, we have supplied to our farmers an improved beet puller, which has given satisfaction.

(8) Average yield of beets per acre, 9.1 tons.

(9) An acre of land suitable for beet crop and convenient to railway station varies in value from $60 to $75 per acre. The rents paid by some of our beet growers are $2.50 to $3 per acre for unplowed land, and $6 to $9 per acre for plowed land.

(10) The cost of producing beets, including hauling and loading in cars, varies from $25 to $30 per acre.

(11) Women and children are employed to a large extent for the hand work in localities which are well populated. On many of the small acreages members of the farmer's family do the entire labor. Compensation for hired help, if given out by contract, is from $18 to $20 per acre, which includes all the hand work—bunching,

thinning, hoeing, pulling, topping, and loading in wagons. Team work—plowing, sowing, cultivating, and plowing out by beet puller—is $2.50 to $3 per day.

(12) In regard to seed, we supply to our beet growers uniform quality of Kleinwanzlebener variety imported direct from producer.

(14) Freight rates on beets range from 50 to 85 cents per ton.

(15) The number of contracting farmers in 1902 was about 2,000.

(16) We never have produced or supplied home-grown seed. Our experiments in that direction have proved a failure. The efforts in that direction should, in our opinion, be put under supervision of officers of the United States Department of Agriculture.

(20) Most of our beet growers have now adopted the method of diversified farming, rotating their crops of small grain, corn, clover, potatoes, etc., with that of beets every two years.

(21) All our beets are produced on a sandy-loam or black-loam soil with a clay subsoil.

REPORT FROM ANOTHER FACTORY.

(1) The season was very unfavorale. There were almost continuous rains during planting and thinning time; also during harvesting.

(2) For beets we paid the farmers an average price of $5.07 per ton.

(3) The number of acres planted to beets was 8,000.

(4) The number of pounds of beets worked, 43,485,600.

(5) The washing process is employed in estimating tare.

(6) Beets are unloaded by hand.

(8) Six tons per acre was about the average yield on acreage harvested.

(9) Land is worth $25 to $40 per acre. Rents range from $2 to $6 per acre.

(10) It costs from $25 to $40 per acre to grow beets.

(11) We depend on local help and extra labor brought from cities. The supply is fair, but the quality is poor. The wages are 15 cents per hour.

(12) We use only foreign-grown seed, which costs the farmers 15 cents per pound. The amount used is 15 pounds per acre.

(13) The beets are hoed not to exceed twice. They are cultivated three to five times, and are irrigated profusely.

(14) Freight rates, under 25 miles, 40 cents per ton; 25 to 40 miles, 50 cents.

(15) The number of contracting farmers was 1,283.

(16) We produce no sugar-beet seed.

(17) The pulp is given to farmers. Very little was used during the past season.

(19) This is a good stock country. There is a cheese factory in this village, and a creamery in an adjoining town. It is a great hay, oats, and stock country.

(20) The land is level, mostly clay loam. The prevailing crops are hay and oats.

CONTRIBUTIONS FROM THE BUREAU OF PLANT INDUSTRY.

PREPARED UNDER THE DIRECTION OF B. T. GALLOWAY, CHIEF.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
Washington, D. C., May 6, 1903.

SIR: I submit herewith, for publication as part of the Report on Progress of the Beet-Sugar Industry for 1902, the following papers: (1) "Single-germ beet balls and other suggestions for improving sugar-beet culture," by Truman G. Palmer, and (2) "Sugar-beet seed: Its importance and production," by J. E. W. Tracy, of this Bureau.

Respectfully,

B. T. GALLOWAY, *Chief.*

Hon. JAMES WILSON,
Secretary of Agriculture.

SINGLE-GERM BEET BALLS AND OTHER SUGGESTIONS FOR IMPROVING SUGAR-BEET CULTURE.

By TRUMAN G. PALMER.

The suggestions made in the accompanying pages for improving some of the methods connected with sugar-beet culture in this country are based on personal observations extending over a number of years. In February last I had the honor to suggest to the officials of the Department of Agriculture the idea of producing single-germ beet balls as one means of materially reducing the necessary quantity of seed, eliminating the labor of thinning and bunching beets, and thereby lowering the cost of producing sugar from beet roots.

While the matter here presented is only suggestive, it is hoped that it may be of value to experimenters and others who are engaged in building up and encouraging an important industry.

TONNAGE AND PRICES OF SUGAR BEETS.

Before treating the subject of increasing the tonnage of sugar beets specifically, an observation as to what is possible of accomplishment from the farmer's standpoint may not be inopportune, although in doing so ground must necessarily be covered which is well known to those who are familiar with the industry.

By experience it has been found that large beets are liable to be low in sugar content, while small beets do not yield sufficient tonnage.

A 2-pound beet gives the best average results. Planting in rows 18 inches apart and thinning to 8 inches gives 43,243 beets to the acre; and if each beet grew to weigh 2 pounds, the yield would be 43¼ tons per acre. This, then, is the maximum yield of ideal-sized beets for factory purposes.

The average yield in Germany is 12 to 13 tons, in Austria 8.5 to 10 tons, in France 10.75 to 12 tons, in Russia 4.7 to 6.5 tons, while in the United States in 1901 it was 9.6 tons, and in 1902, it was 8.4 tons, both of which figures are undoubtedly below the normal average, as both seasons were unfavorable to beet culture in most sections. Fifteen to 18 tons per acre is not an uncommon yield in some localities in this country.

The price of beets in the United States runs from $3.50 per ton for a 12 per cent beet up to considerably more than $5 for the high-grade beets of some sections.

In portions of Nebraska, for instance, where the beets are rather low in both sugar and purity, the price is necessarily below the average, or the factories would be unable to slice them at a profit.

Nature however, recompenses the Nebraska grower, for he is not put to the expense of irrigating as is the case farther west; nor is he compelled to cultivate as extensively as are the beet raisers in some of the more humid States. The factories also recompense the growers by giving them the pulp, which is worth $1.50 per ton for feeding purposes.

Owing to the high sugar content and purity, the price of beets in the mountain States and in portions of some other States, is often in excess of $5 per ton; but fair conclusions can only be arrived at by using the average tonnage and the average price per ton as a basis.

In 1901, the average price throughout the United States was $4.50 per ton. In 1902, the farmers produced a better grade of beets, some of the factories increased the price per ton, and the average was brought up to about $5.

With the low average yield of 9.6 tons at $5 per ton our farmers receive $48 per acre, gross, or a net profit of $18 per acre if we accept $30 per acre as the average cost of production.[a] As compared to the gross average returns from the culture of our leading cereals, the following figures[b] are suggestive:

	Average yield per acre.	Average price per bushel.	Gross returns per acre.
	Bushels.		
Corn	16.7	$0.605	$10.10
Wheat	15	.624	9.36
Barley	25.6	.452	11.57
Oats	25.8	.399	10.29

[a] U. S. Department of Agriculture; Report on the Progress of the Beet-Sugar Industry, 1901, p. 11.

[b] U. S. Department of Agriculture; Yearbook, 1901, pp. 698–705.

If the necessary labor can be greatly reduced and the tonnage doubled or trebled, the agricultural returns in producing at home the raw sugar, for which in 1901 the United States proper sent abroad more than $122,000,000 and for which our people paid the refineries over $159,000,000, will be almost beyond estimation.

In America our inventive genius has largely eliminated hand work in both field and factory, and the most serious obstacle to sugar-beet culture is the hand work of thinning the beets after they are planted and of topping them when they are plowed out.

PULLING AND TOPPING MACHINES.

The work of perfecting a successful pulling and topping machine to do away with hand work and at the same time save $5 to $8 per acre in labor has reached the point where several inventors claim to be absolutely successful. In any event, they have so closely approximated it that perfect success can be confidently expected within a very few years. This will leave only the thinning to be done by hand, and it is to the elimination of this remaining hand work that I desire to direct particular attention.

While a perfect-working pulling and topping machine will save much hand labor and will perhaps slightly increase the tonnage by more perfectly topping the beets than can be done by hand, to remove the necessity for thinning would not only save a like amount in labor but would result in greatly increasing if not doubling the tonnage.

MULTIPLE-GERM AND SINGLE-GERM BEET BALLS.

The prophecy was recently made by the Secretary of Agriculture that sugar would eventually be produced from American-grown sugar beets at a cost of 2 cents per pound. Such a result is only possible by largely eliminating the hand work in the field and by removing one of the main causes of low tonnage, namely, the injury inflicted on the remaining roots by the removal of the superfluous ones.

For several years I have realized that if a beet ball could be bred to produce but one plant the difficulties mentioned would be removed; but no one to whom it was mentioned would admit that science could so radically change the character of plant seed. When the attention of the officials of the Department of Agriculture was called to the subject, they gave it immediate consideration and reached the following conclusions:

(1) That the Department of Agriculture has overcome far more serious obstacles than those which seem to be involved in the production of single-germ beet balls.

(2) That the desired result would be of great value to the beet-sugar industry.

(3) That a series of experiments looking to the desired end should be inaugurated at once.

Investigations and experiments have already been started by the Department of Agriculture, and it is hoped that the State experiment stations may be led to undertake similar lines of investigation. The first questions involved have to do with the selection of single-germ seed already in existence and then the planting and growing of these seeds to get this characteristic fixed. After this is accomplished, of course it will be necessary to follow all of the intricacies of sugar content, size, etc. All of this will take time, and it will undoubtedly require several years before practical results can be attained.

MULTIPLE-GERM BEET BALLS RESPONSIBLE FOR HAND THINNING.

No other work has such an influence on the tonnage as that of thinning. It is the most expensive and laborious work attached to the culture of sugar beets, and to attain the best results it must be most carefully done at the right time.

This careful labor is necessitated by the peculiar character of the beet seed, which, unlike an ordinary single-germ seed, is really a combination of from one to six seeds, each entirely separate and disconnected from the others, but all encased in what is called a "beet ball," an irregular-shaped structure of brittle woody matter about as large as a French pea.

The seeds themselves form but a mere fraction of the ball, the great abundance of woody matter surrounding them being provided by nature to aid the germs themselves in various ways. Soaked in water the porous beet ball will absorb 65 per cent of its weight in moisture in twenty-four hours, and when planted in damp ground rapidly draws the moisture to it.

In planting beet seed the beet balls are thickly drilled in rows, the latter usually being 18 inches apart, and the seeds germinate in two to four weeks, depending upon the condition of the soil and weather, while the weed seeds which are only incased in thin shells are up far in advance of the beets.

When the seedlings are up and have gained sufficient size to show the third leaf they should be thinned. The thinning can not well be done before this time, and if put off until they are larger the pulling up of the superfluous sprouts injures the roots of those which remain, and the result is a low tonnage. The work is done by people on their hands and knees, who pull up the weeds and all of the beets except the most thrifty one to be found about every 8 inches. Most of the beet balls send up several sprouts, each of which would make a beet if allowed to grow, and as the beets can not be grown to advantage in clusters, to secure the best results the separation of the tender shoots must be thorough and should be carefully done at the right time, so as not to injure or disturb the roots of the remaining plant. It was this laborious, careful work that led me to suggest the advisability of securing by selection or by breeding a single-germ beet ball which may be drilled a single ball in a place at any desired distance, and as

each ball would produce but one seedling or beet the superfluous seedlings could be cut off with a three-cornered hoe instead of being pulled up, thus incurring no danger of disturbing the roots of those left to make the crop.

ADVANTAGES OF SINGLE-GERM BEET BALLS.

Some of the agricultural advantages to be gained by securing a single-germ beet ball are as follows:

(1) As with reasonable care the removal of the superfluous beets could not damage any of the roots which are to remain in the ground, a saving of $1 to $2 an acre in seed could be effected.

(2) To-day the farmer's sugar-beet acreage is limited to such an area as he can reasonably expect to secure the necessary labor to thin within a given period after the plants shall show the third leaf. Inasmuch as, with a single-germ beet ball the little thinning necessary could be done with a hoe and need not interfere with the remaining roots, and as this work could be extended over a longer period of time, the farmer could greatly extend his beet plantings with the same amount of available labor.

(3) As none of the roots of the remaining beets would be injured by careless thinning or not thinning at the proper time, the tonnage per acre would be greatly increased.

OBJECTIONS TO SINGLE-GERM BEET BALLS.

After presenting the matter to the Department of Agriculture I laid it before the agricultural experts of each American beet-sugar factory inviting such criticism as might occur to them. Generally speaking, these gentlemen immediately realized the important bearing which such a development would have on the industry. The few objections presented came from territory west of the Missouri River and were as follows:

(1) Owing to the fact that it takes several weeks for a beet seed to germinate and that in the meantime there may be showers or storms, as the result of which the soil may become crusted, fear was expressed that the single beet plants might be unable to break through this crust, whereas clusters of shoots from multiple-germ balls as at present planted do succeed in breaking through.

(2) The second objection urged was that inasmuch as weed seeds start much earlier than those of the beets, so that the weeds are well advanced when the latter come up, oftentimes surrounding and smothering the beets, there would be much less likelihood of securing a good stand where but one seed was planted in a place than where the seeds are thickly drilled in.

As a beet ball will absorb 65 per cent of its weight in moisture within twenty-four hours, and as it must be thoroughly dampened before it will germinate, I can see no good reason why a great por-

tion of this work should not be done prior to planting, instead of waiting for the ball to absorb its full quota of moisture from the soil.

If the germination can be hastened so that the seedlings are up a few days instead of several weeks after planting, the liability of their being unable to get through a soil crusted by showers will be greatly diminished, as, the period between planting and germination being shortened, the danger from showers will be correspondingly reduced.

As regards weeds, the writer is aware of the fact that a sugar-beet field should be free from weed seed before it is planted to beets, but such is rarely the case; and why a farmer should be compelled to plant a dry, woody beet ball, well knowing that before it germinates the soil will be covered with weeds is hard to understand, providing a practical method of soaking the seed before planting can be secured.

The German method of soaking the seed in animal urine not only hastens the germination but imparts additional fertilizing properties to the beet ball, thus producing a more thrifty plant, although sometimes killing some of the weaker ones.

Agricultural science will yet point out a definite method which will not only hasten the germination but benefit the seed without risk of injury.

(3) Another objection offered was that on new Western soil cut worms, beet flies, and other insects are likely to appear when the beet is young, and that, unless a sufficient quantity of seed is drilled in to feed them and still leave enough beets for a stand, they may take all of the beets.

This objection was made to planting a seed every 8 inches. If the seeds were drilled in every 1, 2, 3, or 4 inches there probably would be enough to answer all purposes, and when they had served their purpose the superfluous plants could be removed with a hoe. The increased tonnage resulting from the hoeing would far more than pay for its cost.

(4) Still another objection urged was that it would be difficult to feed wet seed through a drill.

This objection could be easily overcome by allowing the surplus or surface moisture on the beet ball to dry off, when the beet balls, owing to their increased weight, would run through a drill more easily than does the dry seed.

Owing to the saving in labor and to the other advantages to be gained by planting single-germ beet balls, I am firmly convinced that the securing of such a seed will revolutionize the agricultural end of the beet-sugar business and enable our farmers to produce sugar beets at a greatly reduced cost.

THE INFLUENCE OF EARLY THINNING.

The influence of early thinning with the present multiple-germ beet ball is of the greatest importance, and late thinning is largely

accountable for the present low tonnage of beets as compared with a maximum crop of 43¼ tons per acre.

This influence has been thoroughly demonstrated in Germany by the following and other exhaustive experiments most carefully conducted by the best agricultural experts.

The report of these investigations says that four adjoining acres were similarly prepared, planted the same day, and, aside from the time of thinning, all received identical treatment.

The first acre, thinned at the right time, yielded 15 tons.

The second acre, thinned one week later, yielded 13½ tons.

The third acre, thinned two weeks after the first, yielded 10 tons.

The fourth acre, thinned three weeks after the first, yielded 7 tons.

Estimating the value of the beets at $5 per ton, it will be seen that by thinning at the proper time the returns were $75 per acre. One week's delay meant a loss of $7.50 per acre; two weeks' delay caused a loss of $25 per acre; while three weeks' delay resulted in a loss of $40 per acre, bringing the returns down to $35 per acre.

Any further illustrations as to what it means to the farmer to properly thin his beets at the opportune time would seem to be superfluous.

MACHINES FOR PLANTING BEET BALLS.

As described to the writer, one of the machines which has recently been invented for planting beet balls singly is as follows:

A continuous narrow strip of very thin tissue paper tightly rolled up is placed on a spindle. From this spindle the paper is rerolled on another spindle, the paper in the rewinding process being twisted into a cord or small rope. The machine is set so that as the paper leaves the first spindle and the twisting process begins, beet balls are automatically fed into the curved paper at such intervals as may be desired.

When the spindle is filled with the twisted paper containing the beet balls, it is transferred to an agricultural implement which is pulled across the field by horses. As the implement progresses, it makes a trench into which it unrolls the paper rope, covers it with earth, and packs it, thus planting a single beet ball in a place.

Perhaps the inventor did not stop to consider that, with the present multiple-germ beet balls the beets would still come up in bunches, and that consequently his process would not eliminate the necessity for thinning, but this would be a practical method of planting the single-germ balls.

I am informed that a dropping drill has recently been perfected which the operator can set so as to drop a single beet ball in a place at any desired distance. This would be a still more simple and less expensive method of planting single-germ balls, but, as with the paper-strip method, would fail to eliminate the necessity for thinning when planting the present multiple-germ ball.

If there were single-germ beet balls to-day, doubtless within one year there would be a dozen machines on the market any one of which would plant them perfectly.

CRACKING THE BEET BALLS AND SEPARATING THE SEEDS.

The results to be obtained by breeding a single-germ beet ball can be anticipated to some extent by any grower, inasmuch as it is found that a slight cracking of the beet ball suffices to separate the seeds from the woody matter which incases them. Generally speaking, the larger the beet ball the more seeds it contains, though this is not always the case. A grinder or cracker set so as to just sufficiently crack the ordinary four-germ ball would miss a large number of two-germ balls, while if set for the average-sized two-germ ball it would injure many of the germs of a four-germ ball; hence it would be wise to first sift the balls into several lots of different sizes, resetting the grinder for each lot, when little or no injury need result from the crushing.

If these cracked balls were not too closely drilled in, they probably could be thinned with a hoe, but in any event the injury done the remaining roots by any process of thinning would not be as great as where several sprouts come up from a single ball. I believe this method is worthy of careful investigation.

As regards cracking the balls into several pieces, but not separating the seeds from the pieces of ball or husk, one of the American field experts writes me that he has seen "a 4-acre field planted in this same way, the farmer running the seeds through a coffee mill and cracking them, and by planting thus, the seed was well distributed along the row and very few beets came up in bunches. The crop proved a success, and the labor was limited."

CULTIVATION.

There are two other primary causes of low tonnage where natural conditions are favorable: (1) The lack of deep plowing, proper fertilization, and other preparation of the soil, including the elimination of weed seed, all of which can be easily remedied by the most obtuse farmer who is willing to expend a dollar if thereby he can secure $2 in return; (2) lack of thorough cultivation, which is necessary, not only in order to keep down the weeds but to conserve the moisture and aerate the soil.

As to the effect of weeds, certainly every farmer ought to know that every weed that grows takes both moisture and nutriment from the soil, and to that extent injures any near-by vegetable growth. In sugar-beet culture, however, where the farmer is striving for quality as well as quantity, the weeds work a double injury; first, by robbing

the plants of nourishment, and, secondly, by cutting down the sugar content through shading.

Not only do frequent hoeings or cultivations keep the weeds down but stirring the soil permits the air to permeate it, and therein lies one of the great causes affecting the tonnage. As illustrative of what proper cultivation means, an experiment which was recently conducted in Germany may be cited. Five adjoining acres were similarly prepared and planted to beets the same day. The treatment thereafter given to the beets was identical, with the exception of hoeing. As the average price of beets in the United States is about $5 per ton, the last three columns in the following table have been added to show what each of these extra hoeings means to the farmer in dollars and cents for every acre so treated:

Number of hoeings, yield of beets per acre, gains from hoeing.

Acre.	Number of hoeings.	Yield per acre.	Value at $5 per ton.	Extra return by additional hoeings.	Extra return per hoeing.
		Tons.			
First	1	7	$35.00	.....	.....
Second	2	9½	47.50	$12.50	$12.50
Third	3	10½	52.50	17.50	8.75
Fourth	4	12 7/10	63.50	28.50	9.50
Fifth	5	15	75.00	40.00	10.00

In Europe, where labor is cheap and horses are dear, there is not the same incentive to devise implements whereby the work can be done by horses as in the United States where labor is dear and horses are cheap.

The above experiments refer to ordinary hand hoeing, but with our improved cultivators hand hoeing is not so necessary in this country. Even if it were, it is hard to conceive of an intelligent farmer neglecting his beet fields once he is aware of the immense profit to him through giving his sugar beets proper attention.

EFFECTS OF SUGAR-BEET CULTURE.

The influence of beet culture on the farmer's land should also be considered.

This can be done in no better way than by reproducing that portion of the report of one of our consuls to Germany, which treats of the effect of beet culture in rotation with other crops.

The Germans are not only exceedingly systematic, but very scientific, and the following report of exhaustive experiments most carefully made should serve to disillusionize many who still believe that sugar beets rapidly exhaust the soil. The report is as follows:

A German farm of 625 acres produced, before the introduction of beet culture, yearly 9,736 bushels of grain in ten years' average. After beet culture was intro-

duced, with 125 acres yearly to beets, the average yearly grain crop from the remaining 500 acres was 9,870 bushels, or 134 bushels increase. Another farm in the province of Saxony, also of 625 acres, produced before beet culture was introduced, in ten years' average, 13,879 bushels of grain. When five years afterwards 135 acres were planted with beets the grain crop of the remaining 490 acres was 14,365 bushels average, and afterwards, when yearly 220 acres of beets were planted, the average grain crop from the remaining 405 acres was 14,397 bushels, or 518 bushels more than from the whole 625 acres before beets were raised. Thirty-five other farms of 500 to 1,000 acres each in the province of Saxony showed the following results:

Average crops per acre, in pounds.

Crop.	Before beet culture.	After beet culture.	Increase in pounds.	Per cent increase.
Wheat	1,848	2,292	444	24
Rye	1,456	1,672	216	14.8
Barley	1,672	2,094	422	25.2
Oats	1,355	1,918	563	41.5
Peas	985	1,834	849	86
Potatoes	6,716	13,500	6,874	102.3

The average beet crop of these farms was 17¼ tons per acre.

The above demonstration shows that the farmer who rotates his beets with other crops does not decrease the productiveness of his land when sown to other crops but, on the contrary, greatly increases its productiveness. The truth is that a good farmer can not measure his profits by his beet crop alone, but must consider the extra profit which beet culture enables him to make on everything else he grows.

As a matter of fact, the experience in Germany, where every available acre was under cultivation long prior to the introduction of beet culture, would indicate that the money received by the farmers for sugar beets is largely profit, inasmuch as since the introduction of beets these districts, as a whole, continue to yield a greater tonnage of other crops as well as of meat products.

To substantiate this remarkable result I reproduce the following from the report of Mr. M. S. Brewer, American consul-general to Berlin, given under date of November 12, 1881 (see page 479 of Beet Sugar Industry and Flax Cultivation in Foreign Countries, State Department, 1891):

Concerning the beet-sugar industry, a few explanatory remarks may not be out of place. How much the influence is appreciated of the cultivation of sugar beets upon agriculture and national welfare may be seen from a passage extracted from a very valuable treatise by Richard von Kaumann on sugar industry:

It is an established fact that notwithstanding the extensive cultivation of sugar beets, no decrease in the yield of cereals has taken place, but it has, on the contrary, augmented by double and treble the amount in the districts where sugar beets are planted, and that at those very places the production of meat is steadily increasing. The growth of sugar beets requires that the soil be tilled to a greater depth, thus adding to the thrift also of other plants to be cultivated later on the same soil. Besides, the remnants or waste left in the manufacture of beet sugar furnish not only

an excellent food for cattle, but also a fertilizing stuff, dispensing to a considerable extent with the use of artificial manure. But the profit is also considerable which this industry affords people who work in the sugar manufactories, as they get employment throughout the whole year, during the spring and summer seasons, in the growing and cultivation of the beets, and during the fall and winter in the manufactories.

LOWERING THE COST OF SUGAR.

The question is, How can the farmer be benefited and how can sugar be produced from beets in America for less money than the present cost?

It has been stated that the time would come when the American beet-sugar factories would produce sugar at a profit at 2 cents per pound. While this is an eventual possibility, it should be patent to all that such a revolution in cost of production, if brought about, must come largely from the agricultural end of the industry.

To-day the factories pay $5 for a ton of beets from which they are able to extract an average of 219 pounds of sugar,[a] the sugar in the beets thus costing them $2.29 per 100 pounds.

The average cost of working the beets through the factory is $3.18⅞ ter ton,[b] or $1.45 per 100 pounds of sugar extracted.

The cost of bags or barrels is 10 cents per 100 pounds, while freight, commissions, and other expenses bring the present average cost of producing sugar up to $4 per 100 pounds.

When the American farmer becomes educated to the fact, as recently demonstrated by the Colorado Experiment Station, that beet pulp as compared to other stock foods is worth $1.50 per ton, instead of the sugar manufacturer being obliged to throw his pulp away, the farmer will purchase it at a price based on its actual value, the factory proprietor virtually receiving a rebate of 75 cents per ton on the beets he purchases, inasmuch as 2 tons of beets yield 1 ton of pulp. This will mean a reduction of 34 cents per 100 pounds in the cost of the sugar to the factory proprietors, based on the present extraction of 219 pounds of sugar per ton of beets.

The utilization of pulp and other by-products will probably make a total saving in this direction of one-half cent per pound. The 1899 average "factory expense" of $3.18⅞ per ton of beets can perhaps be eventually reduced to an average of $2 per ton, which would make a further reduction of 54 cents per 100 pounds of sugar, resulting in a saving on these two items of $1.04 per 100 pounds.

The above estimate is based on an extraction of 219 pounds of sugar per ton of beets. When the quality of our beets and the efficiency of our factories are increased, as will be the case, and thus the average

[a] U. S. Department of Agriculture; Report on the Progress of the Beet-Sugar Industry, 1901, p. 36.

[b] Report of Twelfth Census, pp. 543–555.

extraction is increased to 12 per cent, or 240 pounds of sugar per ton of beets, the extra 21 pounds of sugar at the present cost of 4 cents will mean a further reduction in cost of 84 cents.

If, from the present average cost of production of $4 per 100 pounds, these three items are taken—50 cents by utilization of by-products, 54 cents saving in factory expense, and 84 cents in extra sugar—the cost will be brought down to $2.12 per 100 pounds. But as the price of sugar goes down, the 84 cents for extra extraction should also be cut down. Cutting this in half would leave the cost of producing sugar at $2.54 per 100 pounds with beets at present cost and all of the above economies carried out; hence, even then, sugar can not be produced for 2 cents per pound.

The success of the industry depends upon the fairness of both farmers and factory proprietors. The price of beets must be so adjusted as to afford each a fair profit, for neither can be expected to work for the sole benefit of the other.

The present New York wholesale price of granulated sugar is $4.65 per 100 pounds, and the price of the product necessarily sets a limit to the price which the factories can pay for beets.

Looking to a lower cost of production the fact must be recognized that the possible factory economies are limited, while the possible field economies and improvements are great.

Gradually reducing the difference between the present average yield per acre and the ideal maximum yield of 43¼ tons, the utilization of the by-products, and the elimination of hand labor in the field are the things which must solve the remaining problems of the industry.

SUGAR-BEET SEED: ITS IMPORTANCE AND PRODUCTION.

By J. E. W. TRACY,
Seed and Plant Introduction and Distribution, Bureau of Plant Industry.

The beet-sugar industry in the United States has made wonderful headway during the last year and promises to continue to greatly increase in importance in the future. There are now 42 beet-sugar factories in the United States, and three rasping stations which manufacture no sugar but extract the juice from the beets and pipe it to a central station for manufacture. Twelve factories are now being built for this year's campaign. The total capacity of these factories and rasping stations is nearly 40,000 tons of beets daily, which requires the planting of from 350,000 to 400,000 acres of sugar beets. The seed required for this purpose aggregates over 5,000,000 pounds, of which less than 200,000 pounds is produced in the United States. The great bulk is imported from Germany, while smaller quantities come from France, Russia, and Austria. The price paid for this seed varies from 7½ to 17 cents per pound, the average being about 9 cents delivered in Chicago or Omaha.

It costs in the neighborhood of 4½ cents to grow a pound of sugar-beet seed in France or Germany, but chiefly because of the greater cost of labor in the United States domestic seed can not be produced as cheaply as foreign seed. California and Washington growers receive 10 cents per pound for their product, exclusive of freight charges.

IMPORTANCE OF FIRST-CLASS SEED.

While the amount of money sent abroad for seed is very large, still it is insignificant in importance compared with the results caused by the use of inferior seed and seed not adapted to the particular locality in which it is to be sown. This has been so clearly brought out by Henry W. Diederich, consul at Bremen, Germany, in Consular Reports No. 242, that I can not do better than quote a portion of his report:

> Sugar is made not in the sugar factories, but out in the fields. Therefore, it is impossible to pay too much attention to the cultivation of beets containing the highest percentage of sugar, and, at the same time, yielding the largest tonnage per acre. In order to produce such, the selection of suitable soil, the climate, the rainfall, and length of season, the fertilizing and planting, the cultivating and harvesting—all are very important factors. But the most important of all is to start out with the best seed obtainable; for good seed, after all, is the foundation of successful sugar industry. If I may express an opinion, based on my personal observation, it is that some of our beet growers should insist more than they have upon getting none but the best of seed, no matter what the price may be. * * * The first-class sugar factories of Europe buy none but the very best seed, grown from high-grade individual "mother" beets, to distribute among the beet growers, thus not only maintaining the standard of their sugar beets as to quality and quantity, but also putting themselves in a position to compete in all the markets of the world. This first-class seed

is sold and delivered by the growers on board cars in the Prussian province of Saxony at from 8 to 10 cents per pound, which is a moderate price, considering the fact that it takes at least four years to get it into the market.

There is also a second-class seed offered for sale in this country at from 5 to 6 cents per pound. This is commonly called the "nachzuchtsamen," being a seed produced not from the mother beets, but from the first-class seed mentioned above. This inferior grade, however, is not used by first-class sugar men in Germany, France, Holland, and Belgium, but most of it goes to Austria, Russia, and the United States. And this is the reason why I deem it my duty to call attention to the importance of getting only the very best seed obtainable. In my opinion, those American growers of sugar beets who buy cheap grades of seed make a great mistake. All kinds of seed have a natural tendency to degenerate. Even the first-class beet seed mentioned above will not bring forth beets that come up to the standard of the original or mother beet, but will show a loss of one-half to 1 per cent of sugar content. Now, the second generation of seed will degenerate more than as much again, and lose from 1 to 2 per cent. This is a small amount, when considered by itself, yet it is sufficient not only to turn the profits of a sugar factory into a loss, but even to drive the concern to the wall.

To illustrate this: Factory A slices 50,000 tons (short) of beets, which would yield about an average of 15.5 per cent sugar in the extraction. After deducting the sugar left in the molasses and in other waste, this would leave about 13 per cent—6,500 tons of pure granulated, marketable sugar, which, at $50 a ton, would net $325,000.

Factory B slices the same amount of beets, grown from second-class seed, which, at a fair average, have about 1.3 per cent less of sugar in the extraction. After this material has also gone through the process of refining, there will be 11.7 per cent—5,850 tons—of marketable sugar, which, at $50 a ton, would net $292,500.

It will be seen at a glance that, while both factories use the same amount of material and have the same expenses for labor, fuel, etc., there is a difference in the gross receipts for manufactured sugar amounting to $32,500.

Factory A bought 55 tons of first-class seed, at $180 per ton, $9,900; Factory B bought 55 tons of second-class seed, at $120 per ton, $6,600. It will be seen that Factory B wanted to buy "cheap" and to make money fast. It did, indeed, save $3,300 at the start; but Factory A began by planting the very best seed obtainable, and came out at the end of the season with $29,200 cash ahead of its competitor, and was in the position of declaring a handsome dividend.

Like so many other things in life, the cheapest beet seed is the dearest. It pays to get the very best, and only the very best is good enough. Let the good work of experimenting in the field of sugar-beet culture continue, in order to learn exactly what we can do in the face of fierce and growing competition; but let American growers determine not only to try different varieties of seed, but also to plant none but seed of high grade and pure pedigree.

It is evident that, if the profitable operation of a sugar factory may depend upon a difference of 1 per cent in the sugar content of the beets, it is of the utmost importance that the seed used should be the best obtainable, and that it should also be adapted to the soil and climatic conditions obtaining in the sugar belt of the United States.

All sugar-beet seed grown in France and Germany is grown under practically the same climatic conditions. This seed is received in America and sown in New York and Michigan, Colorado and Utah, California and Washington, States varying widely in climatic conditions. Yet there is probably no other crop where the profitable invest-

ment of millions of dollars is so directly dependent upon the quality of the seed used as the sugar beet.

The beet-sugar industry is now so well established in the United States that it would be poor policy to depend longer on imported seed, there being always a possibility that by failure of the crop, or for reasons political or owing to trade disturbances, the supply of seed may be cut off. Even if this possibility is regarded as remote, it is nevertheless true that American beet-sugar factories will never attain their maximum profit until there is beet seed especially produced to meet American conditions of soil and climate. Seed is now being grown by private enterprise on a commercial scale in Colorado, Utah, California, and Washington, and on a smaller scale in Nebraska, both at Lincoln and Grand Island. The seed produced in California, Colorado, and Utah is mostly used at or near the place of production, while that produced in the State of Washington has been used for two years in California, where, the grower says, it has given such good results that he has received orders for vastly larger quantities than he is able to produce.

The people of Colorado have been so very well satisfied with their success in raising seed that they intend to greatly increase their areas this year, and ultimately to grow the entire quantity of seed used in growing beets for the factories in that State.

IMPORTED AND DOMESTIC SEED.

During the last year experiments to determine the relative values of foreign and American-grown seed have been commenced at different experiment stations throughout the sugar-beet belt, several varieties of the best foreign seed obtainable having been planted in large plots side by side with seed grown in Washington, Utah, California, and Michigan. The sugar content and purity of the beets grown from each sample of seed were determined twice a year from samples of 50 roots or more. The yields were computed by weighing the entire product of each plot at harvest time.

The reports of this work have been most satisfactory, and have shown quite conclusively that seed raised in America is not only good but of excellent quality, and even superior to many of the highest grades of seed purchased abroad. This is especially marked in the case of seed grown in Washington and in Utah.

BREEDING SEED FROM CHEMICALLY ANALYZED ROOTS.

As far as known, with the exception of the work done at Schuyler, Nebr., by the United States Department of Agriculture, where, in 1893, 5,000 tested mother beets were planted, little or nothing had been done in the United States toward raising sugar-beet seed from

chemically selected mothers until a year or two ago, when the Standard Cattle Company, of Ames, Nebr., working in connection with the Nebraska Experiment Station, began raising seed from chemically analyzed roots. They do not, however, base their experiments on seed from individual roots, but group them into classes according to their sugar content—roots having a sugar content of 14 to 18 per cent are put into one class and those having more than 18 per cent into a second class. Five acres of seed from chemically analyzed roots were grown at Grand Island last year, but with rather unsatisfactory results.

The Department of Agriculture has taken up the work of raising seed from analyzed mothers, and is carrying it forward on an extensive scale at the experiment stations in New York, Michigan, Illinois, Colorado, Utah, and Washington. The best procurable seed from Europe has been secured for this purpose. From the beets grown from each sample of seed a large number of roots have been selected and analyzed and set out as mothers for this year's crop of seed. A careful record showing the sugar content, purity, size, shape, conformity to type, and general growing characteristics of each individual root and its progeny is kept. As soon as a sufficient quantity of seed is raised it will be distributed throughout the different sections of the United States for trial by sugar-beet factories and individuals interested in the work.

The Department will endeavor to further encourage the production of sugar-beet seed by aiding the American growers in distributing their seed as far as possible to bring it to the attention of those interested in sugar beets, and by assisting in breeding sugar-beet seed of high quality from individual mothers for the widely separated districts of the United States having different climatic conditions.

American-grown seed is being used almost exclusively by the Department in connection with its Congressional seed distribution this year (1903); and such seed has also been sent in lots of 100 pounds for a commercial trial to a large number of factories throughout the United States.

THE PRINCIPAL INSECT ENEMIES OF THE SUGAR BEET.

BY F. H. CHITTENDEN, DIVISION OF ENTOMOLOGY.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., June 6, 1903.

SIR: I submit herewith for publication as a part of the report on the Progress of the Beet-Sugar Industry for 1902 a somewhat extended illustrated discussion of "The principal insect enemies of the sugar beet," prepared by F. H. Chittenden, Entomologist in charge of breeding experiments of this Division.

Respectfully, L. O. HOWARD, *Entomologist.*

Hon. JAMES WILSON,
Secretary of Agriculture.

INTRODUCTORY.

Although the beet-sugar industry is still in its infancy in America, already many insects—150 species in round numbers[a]—have been found to use beets as food, and, while comparatively few occasion losses of consequence, with the coming of years and the increase of cultivation of the sugar beet, other insects will acquire the habit of feeding upon it, and more extensive injuries may be expected each successive season.

If we leave out such forms of insects as blister beetles, army worms and cutworms, flea-beetles, leaf-beetles, and some few others, we may say that beets at the present time suffer comparatively little damage through insect ravages. The recent extension, however, of sugar-beet culture in this country has been the means of bringing to notice, through the publications of the Department of Agriculture and several of the State experiment stations,[b] a large number of insects not previously identified with attack on that plant.

A very considerable proportion of the insect enemies of sugar beet, which are practically identical with those which affect table beet and

[a] Forbes & Hart, Bul. 60, Univ. Ill. Agl. Expt. Sta., 1900, pp. 397–532.

[b] See Bruner, Bul. 23 [old ser.], Div. Ent., U. S. Dept. Agriculture, 1891, pp. 11–18; Osborn & Gossard, Bul. 15, Iowa Agl. Expt. Sta., 1891, pp. 265–272; also numerous shorter articles.

spinach, subsist normally on wild plants of the same botanical order—the Chenopodiaceæ, or goosefoot family, which includes our common lambsquarters (*Chenopodium album*), spinach, and some related plants that are cultivated for ornament and as forage crops. Of the latter are several forms of saltbush (Atriplex). Many beet depredators also live on plants belonging to an allied family—the Amaranths—which contains many common weeds, including pigweed, as well as a few ornamental forms.

One of the earliest instances of injury to the beet reported in America is that furnished by our first economic entomologist, Harris,[a] in 1841. In quite recent years, however, several species have been so prominent as pests in fields of sugar beet that they have received names indicative of their beet-feeding habit, while a few take their common names from spinach. Among these are the beet army worm,[b] the beet webworm,[c] the beet or spinach leaf-miner,[d] spinach flea-beetle,[e] beet carrion beetle,[f] beet aphis,[g] European beet tortoise beetle,[h] and two species of leaf-beetles.[i] Of the various insects known to live on this plant, not more than about one-third, or 40 or 50 species, can be classed as noticeably destructive to it.

It is difficult to decide at this time, owing to the lack of study given the subject over the entire country where beets are raised, which forms of insects are of the highest importance. The different insects which have been mentioned specifically are more attached to beet and spinach than to other plants, and the greatest losses, if we take the entire country into consideration, are probably due to the ravages of flea-beetles, but they, as well as cutworms and similar groups, are so periodical or, more properly speaking, irregular in their depredations that an exact estimate of their economic status can not be made. Different species of leaf-beetles and caterpillars other than cutworms do more or less injury, and several blister beetles devour the foliage of sugar and table beets freely; most forms of the last, however, usually make their appearance so late in the season that, although defoliation may be excessive, comparatively little damage is accomplished. The same is true of some species of grasshoppers.

Beets until recently were comparatively free from subterranean insect enemies, but there are two forms of common farm pests, white grubs and wireworms, that affect underground portions of the plants and occasionally injure them; in addition to these, some kinds of root-lice and mealy-bugs injure the roots by suction, rendering them small

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[a] The species mentioned is the zebra caterpillar (*Mamestra picta*). Rept. Ins. Mass. Inj. to Veg., p. 328.

[b] *Caradrina exigua.*

[c] *Loxostege sticticalis.*

[d] *Pegomya vicina.*

[e] *Disonycha xanthomelæna.*

[f] *Silpha opaca.*

[g] *Pemphigus betæ.*

[h] *Cassida nebulosa.*

[i] *Monoxia puncticollis* and *M. consputa.*

and soft or spongy when they do not kill them outright. Some other sucking insects—plant-lice, plant-bugs, leaf-hoppers, and the like—occasionally injure the plants by absorbing their vital juices, but with some notable exceptions they are comparatively unimportant as beet pests.

Many of the most destructive or best known sugar-beet pests have received more extended notice in recent publications of the Division of Entomology, notably in Bulletins 19, 23, 29, 33, and 40, new series (from which the present article has been largely collated), in addition to other publications which have been cited in the introductory paragraph and others which will be mentioned in connection with the different species as they are considered.

In indicating methods of control to be observed for insects which are not special enemies of the sugar beet, it has been found necessary, owing to our somewhat imperfect acquaintance with all of the conditions which surround attack, to treat the subject in a general manner. The remedies for different forms and classes of insects are therefore considered as they occur upon the farm. Where deemed advisable, however, an effort has been made to limit remedial directions to the occurrence of many of these insects in fields of sugar beet. It may therefore be stated that as a general rule remedies prescribed for insects as these occur on their favorite food plants also serve for their destruction on other crops. Exception is made of insects such as the southern corn root-worm, which is a prime enemy of corn, though the beetles are usually to be found in beet fields, since the elaborate treatment which is often necessary in combating this pest on corn, need not be employed on beets and other crops where its injuries are comparatively insignificant.

LEAF-BEETLES AND FLEA-BEETLES.

Several leaf-feeding beetles of the family Chrysomelidæ, known as leaf-beetles and flea-beetles, are quite conspicuous as enemies of the sugar beet. Three of the leaf-beetles are apparently peculiar to beets among cultivated plants, injuring them both in the adult and the larval stage, while numerous flea-beetles, although as a rule general feeders, are even more destructive by attacking the plants early in the season, when they are least able to withstand injury.

THE LARGER SUGAR-BEET LEAF-BEETLE.

(*Monoxia punctipollis* Say.)

With the cultivation of the sugar beet in the West there has come to prey upon it a moderate-sized leaf-beetle, known in parts of New Mexico as the "French bug."[a] Its presence in beet fields was first

[a] See the author's article, Bul. 18, Div. Ent., U. S. Dept. Agr., p. 95.

noticed simultaneously in that Territory and in Colorado in 1898, when it did serious injury to crops. The beetles are gregarious, sometimes occurring "in swarms like blister beetles." Their brownish gray eggs are deposited in irregular masses, usually on the under sides of leaves. They hatch in about six days, and their larvæ or young commence feeding at once, continuing for nine or ten days, when they dig their way into the ground, a few days later coming forth as beetles. Although the beetles do much injury, the principal damage is sometimes accomplished by the larvæ, hundreds being found on a single small plant, which is either consumed or so injured that it shrivels and dies. In 1902 this insect did considerable injury to sugar beet in Colorado.[a] It feeds on several wild plants, blites (*Domdia americana* and *D.*

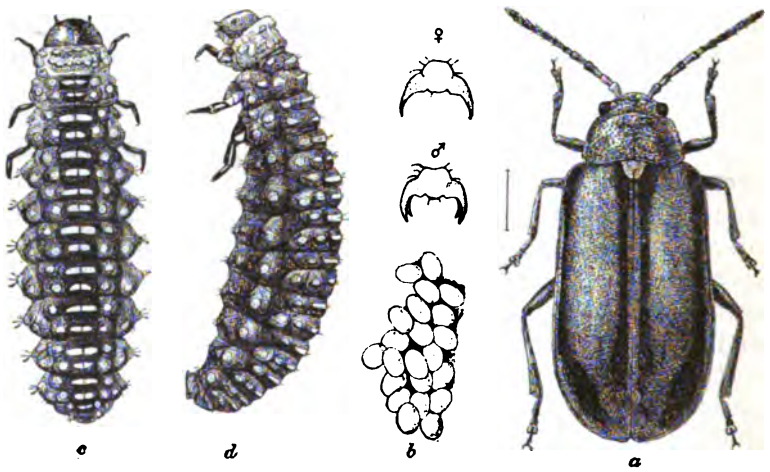

FIG. 1.—*Monoxia punctieollis: a*, female beetle; *b*, eggs; *c*, larva, dorsal view; *d*, larva, lateral view; ♂, claw of male; ♀, claw of female—all much enlarged, male and female claws more enlarged (author's illustration, Division of Entomology).

depressa), Russian thistle (*Salsola tragus*), and saltbush (*Atriplex argentea*), is double-brooded according to Prof. C. P. Gillette,[b] and occurs throughout the summer.

This species is related to the imported elm leaf-beetle, but is larger and differently marked. The beetle is quite variable, both as regards the markings and size, the length being from one-fourth to one-third of an inch. It is of oblong form, narrow in front. The color varies from pale yellow to entirely black, while the elytra or wing-covers are more or less distinctly striped. The surface of the thorax is coarsely and irregularly punctate. Five varieties or races are recognized. The beet-feeding form is illustrated in figure 1, *a*. The larva, shown in the same illustration, *c*, *d*, measures when full grown about one-third

[a] Bul. 40, Div. Ent., pp. 111–113.

[b] Twenty-fourth Rept. Colo. Agric. Expt. Sta., 1902, pp. 108–111.

of an inch in length. The general color is nearly uniform dark olive brown, the conspicuous piliferous tubercles being pale yellow, and the head and portions of the legs black. The eggs (*b*) are dull brownish gray, and the surface, as seen through a lens, is covered with septagonal and hexagonal areas.

A common variety of this species, not thus far noticed, however, in beet fields, is illustrated in figure 2. It has been observed in Nebraska, Texas, and Florida.

Remedies.—This and the Western beet leaf-beetle are apt to become important enemies of sugar-beet culture unless remedial measures are instituted. The general methods for the control of leaf and flea-beetles (see page 169) are all applicable, but a few remarks should be added in regard to particular remedies for these two species. Paris green, London purple, and paragrene have all been employed against the larger species with apparently good results when applied dry, mixed with flour, in the same manner as for the Colorado potato beetle. Against the Western species a spray of Paris green with whale-oil soap has been used with success, the beneficial effect lasting about six weeks, the beet leaves not being injured. There is no especial advantage in the addition of the soap, and the arsenical used alone or with Bordeaux mixture would have answered still better.

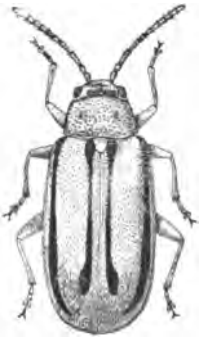

FIG. 2.—*Monoxia punctipollis*, variety—5 times natural size (author's illustration, Division of Entomology).

Two interesting facts brought out in the course of Professor Gillette's observations on the larger insect in Colorado are of value as indicating methods of control. It was observed that the beetles accumulated quite largely upon "mother" beets early in the spring, which suggests that if a few beets be left in the ground over winter they will serve as trap crops for the protection of the younger plants in spring. It was noticed also that the insect appeared to confine its injuries to plants growing in alkali ground or in close proximity to such soil. Hence such ground is to be avoided for the cultivation of beets.

THE WESTERN BEET LEAF-BEETLE.

(*Monoxia consputa* Lec.)

Garden as well as sugar beets are injured by this species, particularly along the Pacific coast. It first attracted attention in the years 1890 and 1891 in Oregon, where it did considerable injury (F. L. Washburn, Bul. 14, Oregon Agl. Expt. Sta., p. 11.). It eats holes through the leaves, in some instances leaving only a network of the original leaf, and this seriously interferes with the growth of young plants, which are sometimes killed.

This beetle (fig. 3) is smaller than the preceding, measuring only about one-sixth inch in length; is pale yellowish brown in color and moderately variable, some individuals being plain, while others are marked with black spots arranged in nearly regular series.

It is a Western species, but ranges as far eastward as the Dakotas, and is found in Montana, Utah, Colorado, Kansas, Arizona, and the Pacific States. There is no record of injury by the larva, but there is little doubt that it also affects this plant, and in much the same manner as does that of the larger sugar-beet leaf-beetle. Injury has been noticed in Oregon toward the end of August, continuing for six or eight weeks.

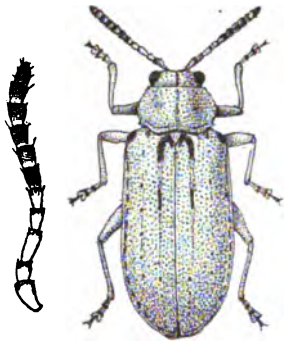

FIG. 3.—*Monoxia consputa:* beetle, 8 times natural size; antenna at left highly magnified (original, Division of Entomology).

THE SOUTHERN CORN ROOT-WORM.

(*Diabrotica 12-punctata* Ol.)

As this species is present everywhere in beet fields the year round, it is familiar to most beet growers. The adult is best known in the North as the twelve-spotted cucumber beetle, from its partiality for flowers of cucumber and related plants. In the South the young or larva is called the "bud worm" from its pernicious habit of burrowing into and eating young cornstalks soon after the germinating period.

The beetle (fig. 4) measures nearly one-fourth of an inch in length, is yellowish-green in color, and the elytra or wing-covers are marked with twelve black spots.

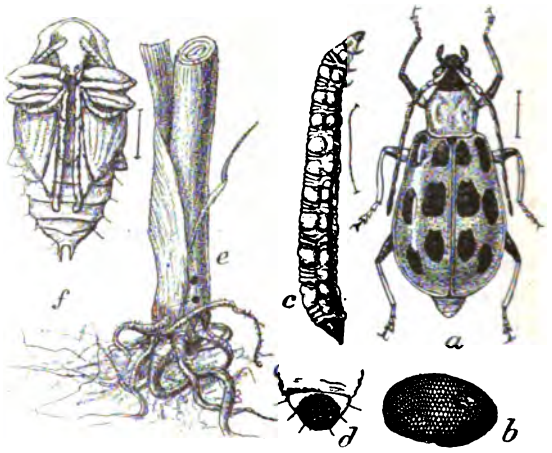

FIG. 4.—*Diabrotica 12-punctata: a*, beetle; *b*, egg; *c*, larva; *d*, anal segment of larva; *e*, work of larva at base of cornstalk; *f*, pupa—all much enlarged except *e*, which is reduced (reengraved after Riley, except *f* [original], Division of Entomology).

This beetle is practically omnivorous, feeding upon almost any form of vegetation upon which it happens to alight. Although very fond of flowers, it is liable to attack any portion of a plant, finding food on the foliage and other portions of most garden and many field crops, the flowers and leaves of fruit trees, and the bloom of many ornamental plants. The larva develops on the roots of grasses, as well as corn, and even on beans and some other plants. The beetles have been

accused of being carriers of various plant diseases, and probably with justice, since they have a habit of flying frequently from one plant to another, feeding on each in turn. In the leaves of beets and other vegetables they make many small, irregular holes, and are capable of doing considerable damage when occurring abundantly on young plants. It is not known how many generations are produced during the year, but as the beetle is one of our earliest as well as latest species, it seems probable that two or perhaps three generations may be produced annually, at least in the more southern States.

Remedies.—Ordinary leaf-beetle remedies are applicable to this species in its occurrence on beets. On cucumber and other cucurbits, however, it is more troublesome, and must be treated in about the same manner as the striped cucumber beetle (see Circular No. 31, Div. Ent.). On corn it is still more difficult to control the root-worms, and this subject will be reserved for discussion elsewhere. The results of experiments with remedies are given in an article on this species by A. L. Quaintance (Bul. 26, n. s., Div. Ent., pp. 39–40).

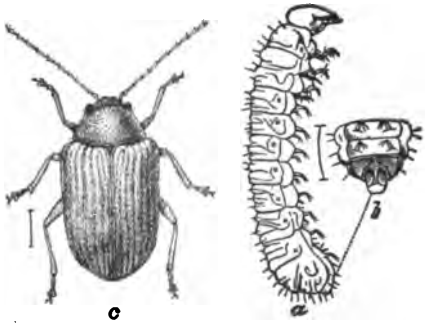

FIG. 5.—*Colaspis brunnea:* *a*, larva or root-worm; *b*, anal segment of larva from above; *c*, beetle—all enlarged (*a*, *b*, after Riley; *c*, original, Division of Entomology).

THE COLASPIS ROOT-WORM.

(*Colaspis brunnea* Fab.)

This species is best known as a depredator upon grape and strawberry, on which the larvæ also subsist, whence two of its vernacular names of grapevine colaspis and strawberry root-worm, but it has frequently been noticed on sugar beet in Nebraska and Illinois. It is also often found attacking the foliage of beans.

The beetle is common and well known. It is exceedingly variable, but typical specimens are yellowish or pale brown, dull or moderately shining, the elytra and legs are a little paler than the other portions. The form is oval, slightly oblong, and moderately convex, the general appearance being about as represented at figure 5, *c*. The larva[a] is a white cylindrical grub, about an eighth of an inch long, with a yellowish-brown head. The pupa is also white and has simple, incurved anal hooks.

This beetle has been recorded as doing more or less injury to several plants other than those mentioned, including potato, buckwheat, corn, clover, beans, cowpea, muskmelon, cotton, and some wild plants, including tick trefoil and New Jersey tea, and the leaves or blossoms of apple, pear, and willow. The larva has also been observed

[a] For particulars the reader is referred to 22d Rept. State Ent. Ill., 1903, pp. 145–149; also Bul. 9, n. s., Div. Ent., p. 21.

feeding on the roots of timothy and other grasses, and Indian corn, in addition to clover, strawberry, and grape, which would lead to the belief that the species might have been originally a grass-feeding one.

There is little doubt that the insect is single-brooded, and it has been surmised that it hibernates as a partly grown larva. The beetles which are to be found from June to September probably also hibernate.

THE BEET TORTOISE BEETLE.

(*Cassida nebulosa* Linn.)

An illustration of this species (fig. 6) and a short notice of it is presented, for the reason that it is one of the few insects which derive their common names from the beet, and because it is destructive to sugar beet in Europe. There is, moreover, some likelihood of its becoming a pest in our own country if it should ever be able to obtain a permanent foothold here. It is reported as having been observed in California in 1894, but as we have heard little of the insect since that time some doubt exists as to its actual establishment in America. It ranges through Europe and in Asia from Persia to Siberia, and it may be that it is destined to become cosmopolitan. Therefore beet growers should be warned against it. In Europe this beetle feeds on lambsquarters, Atriplex, and related plants, but when these plants become exhausted it devastates large areas of sugar beets. There are said to be two generations of the beetles produced annually, one appearing in August, the other in the autumn. The beetle is about one-fourth of an inch long and yellowish gray or pale green in color.

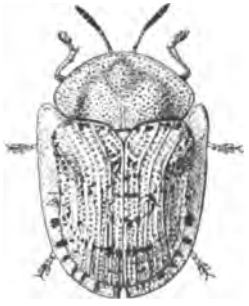

FIG. 6.—*Cassida nebulosa*: beetle, about 4 times natural size (original, Division of Entomology).

Remedies.—The same remedies advised against other leaf-beetles would apply to the present species.

THE SPINACH FLEA-BEETLE.

(*Disonycha xanthomelæna* Dalm.)

Flea-beetles are among the most important enemies of the sugar beet, and of growing importance, as recent reports bear testimony. No less than a score of species have been observed to attack beets. Among the most destructive of these are the spinach flea-beetle, the pale-striped flea-beetle, and the black and red-headed flea-beetles, well-known forms in the East; but in some portions of the West and elsewhere others do more damage. They are most troublesome on very young plants.

Reports of injuries by the spinach flea-beetle to cultivated plants

are rapidly increasing, although it continues to live by preference on weeds and wild plants. The crops most injured are beets, spinach, and saltbush; and natural food plants are chickweed and lambsquarters. The leaves of these plants are riddled with holes, chiefly the work of the larvæ, but also of the beetles, and gardeners complain that spinach may be so badly worm-eaten that it is impossible to offer it for sale. Considerable injury to beets was observed by the writer in 1900, and during 1902 and 1903 the insect has been the most conspicuous species on sugar beet in and near the District of Columbia.

The larvæ, as well as beetles, drop quickly upon being disturbed, and as the former are inconspicuous in appearance, and the latter feign death, the miscreants are apt to elude recognition, the early injury produced being frequently ascribed to cutworms and the later damage to other insects. Frequently from 15 to 20 larvæ live on a single leaf. They feed mostly on the under surface.

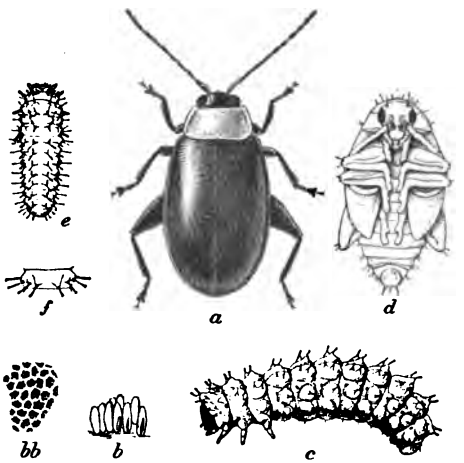

FIG. 7.—*Disonycha xanthomelæna*: *a*, beetle; *b*, egg mass, showing mode of escape of larva at right; *bb*, sculpture of egg; *c*, full-grown larva; *d*, pupa; *e*, newly hatched larva; *f*, abdominal segment of same—*a*, *c*, *d*, five times natural size; *b*, *e*, more enlarged; *bb*, *f*, still more enlarged (author's illustration, Division of Entomology).

The beetle (fig. 7, *a*) is shining black, sometimes with a greenish or bluish luster. The prothorax and abdomen are red or reddish yellow, and the legs and antennæ pale yellowish. It measures less than one-fourth of an inch. The buff or orange eggs (*b*, *bb*) are deposited in masses. The mature larva (*c*) as it occurs on sugar beet is dull leaden gray, with darker head and still darker brown mouth parts, but on red and purple beets it takes on the color of the plant attacked. This is a native species and of exceptionally wide distribution, its habitat extending from New England to Montana, and from British America to Florida and Texas. It is one of our earliest spring visitors, appearing in the first warm days of March in the Atlantic States, and continuing abroad some years through November. Two generations occur in the District of Columbia, the first usually produced on chickweed, and later ones on beets, spinach, and other plants. It is a prolific insect, as many as 180 eggs having been observed to be deposited by a single female.[a]

[a] A more complete account of this flea-beetle is given in Bul. 19, n. s., pp. 80–85.

THE PALE-STRIPED FLEA-BEETLE.

(*Systena blanda* Mels.)

This species, a beet feeder of long standing, has in recent years come to the front as an important enemy to sugar beets, and table beets are also affected. In 1899 and 1900 much injury was done to sugar-beet fields in Michigan, some having been practically destroyed while the plants were quite young. During 1900 much injury was done in Colorado, the beetles appearing in swarms of millions and practically killing plants of two or three weeks' growth. Older plants were considerably checked in development, but not destroyed. The next year beets were injured in South Carolina and Indiana.

This is one of our commonest, most nearly omnivorous, and most destructive flea-beetles. It measures about an eighth of an inch, is cream-colored, with nearly black abdomen and eyes, and striped wing covers (fig. 8, *b*). The larva is white and slender, with light brownish-yellow head. It is an American species and of rather wide distribution, from New Jersey and Pennsylvania southward to Georgia, and westward to California.

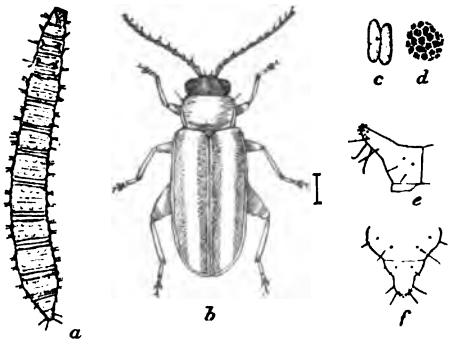

FIG. 8.—*Systena blanda:* *a*, larva; *b*, beetle; *c*, eggs; *d*, sculpture of egg; *e*, anal segment, from side; *f*, same from above—*a–d*, six times natural size; *e*, *f*, much enlarged (author's illustration, Division of Entomology).

The pale-striped flea-beetle, though a general feeder, is particularly fond of the foliage of beets and beans. Potatoes and corn it also injures very much, while considerable damage to melons and other cucurbits, turnips and other crucifers, tomatoes, peas, carrots, and eggplant has been observed. The beetles also attack strawberry, clover, cotton, oats, and peanuts, and injure the leaves of pear, as also pear grafts, by eating out the terminals, thus stunting the growth of the trees. They sometimes do severe injury in three or four days.

The species hibernates as a beetle, and appears above ground in the vicinity of the District of Columbia early in June; egg laying evidently continues through that month and to the middle of July, if not two or three weeks later; injury is usually due to the beetles upon their first appearance; and almost any valuable crop may be injured, either in the absence or presence of the wild food plants.

The larvæ live below ground, and have been observed by the writer and others feeding on the roots of corn, lambsquarters, and Jamestown weed. They probably live also on pigweed (Ambrosia), cocklebur (Xanthium), and other weeds, as the beetles are commonly found on these plants.

THE BANDED FLEA-BEETLE.

(*Systena taeniata* Say.)

The banded flea-beetle also frequently attacks beets, beans, and other vegetables, particularly in the West and Southwest. It has similar habits to the preceding species and similar structure; it was, in fact, until quite recently very generally confused with the pale-striped form, and many references to injuries by this species are really due to the latter. Like the latter it varies considerably as regards color and punctation. It is polished black, with white stripes. A common dark form of the beetle is shown in figure 9.[a]

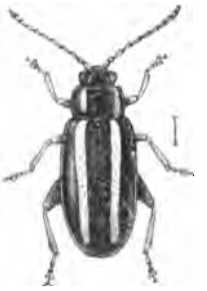

FIG. 9.—*Systena taeniata*, dark variety—about 6 times natural size (author's illustration, Division of Entomology).

THE RED-HEADED FLEA-BEETLE.

(*Systena frontalis* Fab.)

This species (fig. 10) resembles in its habits the two flea-beetles that have just been mentioned. Its color is shining black throughout except the major portion of the head, which is red. It has been known as an enemy of beets since 1891. It also attacks potato and beans, but is not restricted to vegetable crops, being quite fond of the foliage of fruits, including grape, gooseberry, pear, and others. It inhabits practically the entire arable region east of the Rocky Mountains, including southern Canada and the Southern States (Bul. 33, n. s., Div. Ent., pp. 111–113).

FIG. 10.—*Systena frontalis*—much enlarged (author's illustration, Division of Entomology).

THE SMARTWEED FLEA-BEETLE.

(*Systena hudsonias* Forst.)

From the red-headed flea-beetle this differs in being uniformly shining black. Otherwise the two species are very similar. Taken all in all, it is perhaps the most abundant of the flea-beetles which have been mentioned, but, although it shows a fondness for a number of crop plants, including sugar beet, potato, grape, beans, and sweet corn, it is much more confined to weeds (L. c., pp. 113–114).

The larval habits of the three species last mentioned have not been positively ascertained, but there is little doubt that they will be found to be much the same as those of the pale-striped flea-beetle, since the beetles of all of them occur in greatest numbers on the same species of weeds, and, even when occurring in moderate abundance, seem to show little preference.

[a] This and the preceding species are discussed in Bul. 23, n. s., Div. Ent., p. 23.

THE WESTERN CABBAGE FLEA-BEETLE.

(*Phyllotreta pusilla* Horn.) [a]

In some of the Western States not inhabited to any extent by any of the preceding species there is a small dark-colored flea-beetle uniformly deep polished olive green, with the surface irregularly punctate (fig. 11) which, as its English name indicates, affects more particularly cabbage and related crops. During 1901 it was observed doing considerable damage to sugar beet in portions of Colorado. It prefers the younger plants, and as instance of its destructiveness one grower reported that he had not raised a turnip for seven years on account of its ravages. Between 10 and 20 acres of corn were reported destroyed on one farm in twenty-four hours, the beetles sometimes coming in swarms like black clouds and covering the plants. This flea-beetle ranges from the Dakotas to Mexico, and westward to southern California, being found in numbers at high elevations in the Rocky Mountain region.

FIG. 11.—*Phyllotreta pusilla*—much enlarged (after Riley, Division of Entomology).

REMEDIES.

The arsenicals, especially Paris green, are the most useful remedies for leaf-feeding beetles, and since Bordeaux mixture is extremely distasteful to flea-beetles, this, if mixed with the insecticide and applied as a spray, is more effective than when the arsenical is used dry. Against some species, however, Paris green mixed with 20 parts of flour and dusted on infested plants has been found satisfactory, while kerosene emulsion and even strong soap washes have been found useful in combatting others. When the plants are quite young the spray can not be so well used as after they have attained larger growth, but the dry mixture can then be applied with best results. Bordeaux mixture used alone is valuable as a deterrent.

Clean culture is also of the greatest value. It consists in keeping down weeds which serve as food for the beetles and as breeding places for their larvæ. Against the spinach flea-beetle we have to destroy the chickweed and lambsquarters of the vicinity and to avoid the planting of beets and spinach in ground which has become overgrown with these plants. For the pale-striped flea-beetle, lambsquarters, cocklebur, and pigweed should be destroyed, while for insects like the smartweed flea-beetle practically all weeds in the vicinity must be pulled up and destroyed, as this insect feeds on nearly all forms of useless vegetation. The time for performing this work varies according to

[a] In early publications, for example, in the Report of this Department for 1884, p. 308, this insect was mentioned as *Phyllotreta albionica* owing to the fact that the two species had not been separated, *albionica* being the older name.

the species concerned, and with locality and season. In general terms, it may be said that the best time is after the beetles have laid their eggs and before the young or larvæ have attained full development. For most species this would be about three weeks after the first appearance of the beetles in numbers. A spraying of the upper surface is sufficient for most flea-beetles, but for the spinach flea-beetle it is necessary to apply a spray to both the under and upper surfaces in order to reach the larvæ which feed in exposure on the lower surfaces of plants.

THE BEET AND SPINACH CARRION BEETLES.

Among insects particularly attached to beet and spinach are two, known respectively as the beet and the spinach carrion beetles. They are nearly unique among carrion beetles (Silphidæ) which subsist chiefly on decomposing animal matter, this being the normal habit of the family. The two species in question are also found under carcasses and in garbage. From their dual habit of living both on carrion and on beets and spinach they derive their English names.

THE BEET CARRION BEETLE.

(*Silpha opaca* Linn.)

This species is mentioned in the preface as particularly attached to the beet. In some parts of Europe it is a very serious pest, more particularly in Germany, France, Austria, and England, although it is rather generally distributed on that continent, occurring in Siberia. In Germany it has been described as "by all odds the most troublesome pest" with which beet growers have to deal. The species was identified in 1880 from specimens collected in California and "Hudson Bay," and it seems probable that it was introduced on the Pacific coast, and has recently made its way to Nebraska, where it was found attacking beet in 1891.[a] There is some danger that at some future time it may become a more serious pest, such as it now is in its native home.

The beetle is black and of similar appearance to our common carrion beetles. The body is elongate, or oblong-oval, with the sides comparatively parallel. It is much flattened, and the elytra at the sides are thin and slightly reflexed or turned up. There is also a small prominence near the end of each, the middle costa or ridge of the elytron extends nearly to the posterior margin, and the tip of the abdomen is dull red. The length is about three-fourths of an inch.

The larvæ are shining black, and of similar appearance to our common sowbugs (Oniscus), creatures commonly found in fence corners and in cellars, and they, with their parents and others of their kind,

[a] Bruner, Bul. 30 (old series), Div. Entomology, p. 40.

occur under carcasses of small animals, such as rabbits and birds, and in garbage.

The eggs are probably laid usually in decomposing material, but it has not been ascertained where they are deposited in beet fields.

The larvæ are nocturnal, feeding chiefly in the evening and early morning, and concealing themselves during the heat of the day about the roots of the plants affected. They first attack the parenchyma or outer surface of a leaf, leaving the skeleton more or less intact; but when in numbers they consume entire leaves, sometimes eating them down to the ground. Afterwards they attack the roots. Where the leaves are not severely eaten the plants recover, but if the foliage is destroyed the plants usually die. The species is probably single-brooded. As soon as the larvæ become full fed injury ceases and the plants, if not too seriously damaged, begin to take on new growth. Larvæ descend into the soil to a depth of three or four inches and there change to pupæ and afterwards to beetles, in which stage they pass the winter undisturbed and free from natural enemies until the following spring, when they reappear.

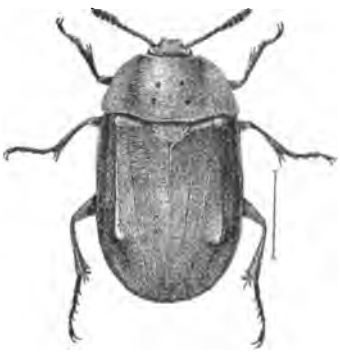

FIG. 12.—*Silpha bituberosa*: adult—much enlarged (original, Division of Entomology).

THE SPINACH CARRION BEETLE.

(*Silpha bituberosa* Lec.)

This species resembles the preceding, both in appearance and habits, but differs in some important particulars, being a native species and restricted, so far as injurious occurrences are concerned, to the Northwest Territories and neighboring portions of British America. It occurs, however, also in northern Kansas, from which State it was originally described in 1859, and in Wyoming and Montana. Unlike the preceding species, it attacks other vegetation than beets, although it seems probable that it fed originally on plants of that family, such as lambsquarters and another weed native to the Northwest (*Monolepis nuttalliana*). Other food plants are squash and pumpkin. The insect seems capable of being quite destructive to all of these crops. Some vines of the pumpkin have been entirely destroyed. In Alberta the larvæ have been reported as swarming in gardens in the spring, devouring leaves of spinach and beet.

The spinach carrion beetle (fig. 12) is much broader than the beet carrion beetle, being more nearly oval, whereas the latter is elongate oval. It measures nearly half an inch and is of the same black color. The larva is polished black and does not appear to have been differentiated from that of the preceding.

In its life history it doubtless closely resembles the European importation in feeding on both carrion and vegetation. Whether or not the beetles also injure plants does not appear to be known. Attack by the larva begins in the latter part of May, extending through June, and probably into July in the more southern and warmer range of the species.[a]

REMEDIES.

The remedies in use against the Colorado potato beetle are applicable to these carrion beetles. Paris green, applied either dry or in spray, as directed for leaf beetles, and clean culture are about all that are necessary, but it is also advised in the treatment of the native species that the weed Monolepis be sown in the vicinity of spinach, beets, and gourd crops subject to attack, to serve as a lure to draw the insects from the crops. On the trap plants they can be more easily destroyed, and by various means.

BLISTER BEETLES.

Blister beetles are among the most conspicuous of all enemies of the sugar beet, no less than a dozen species having been observed doing more or less injury to this crop. One or more species are generally found in beet fields, and, in fact, the arable regions of the United States are probably never free from them. In the East four or five species are common, and in the Southwest there are a few more extremely destructive species. Most blister beetles are better known as potato pests, but next after potatoes beets appear to be the favorite food of many of them. After this they attack other vegetable crops, some favoring beans, peas, and other legumes, while almost any of them will attack whatever comes next in their line of march. They are gregarious, congregating in great numbers, and some have the truly migratory habit, feeding voraciously, running with great rapidity, and flying from time to time. Thus it happens that they frequently descend in such numbers on a field that an entire crop is ruined beyond recovery in a few days, when the insects disappear and are perhaps seen no more until the following year. After the departure of one species of blister beetle another frequently follows, to be replaced by a third, and so on.

Some species, though apparently very destructive, appear so late in the season that, although beet plants are sometimes nearly defoliated, a fair crop may be gathered in spite of the loss of the leaves, a new growth of which is sometimes put forth. The roots, morever, are not touched.

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[a] General accounts of this insect have been published by Dr. James Fletcher. (Rept. Ent. Can. Exp. Farms for 1893 [1894], pp. 20, 21; for 1897 [1898], page 198, etc.)

In their life history blister beetles differ greatly from other Coleoptera in that they undergo a more complicated series of metamorphoses which will be explained and illustrated in the account of the striped blister beetle which follows.

Blister beetles are not an unmixed evil, since they do some good in their larval stage to compensate in a measure for the harm the beetles occasion to our crops, for the habit of the larvæ of destroying grasshopper eggs renders them of material aid in keeping these pernicious insects in check. This is especially true in the Western States, where both blister beetles and grasshoppers abound. But the benefits derived are really more than counterbalanced by the losses occasioned in fields and gardens; hence, insecticides and other measures should be employed to destroy the beetles when they occur in harmful numbers.

As blister beetles are to be found in practically all fields of sugar beet, and are among the most prominent enemies of this plant, it is purposed to consider several of the most abundant species.

THE STRIPED BLISTER BEETLE.

(*Epicauta vittata* Fab.)

Before the advent of the Colorado potato beetle in the East this was our most destructive potato insect, and probably because it is also

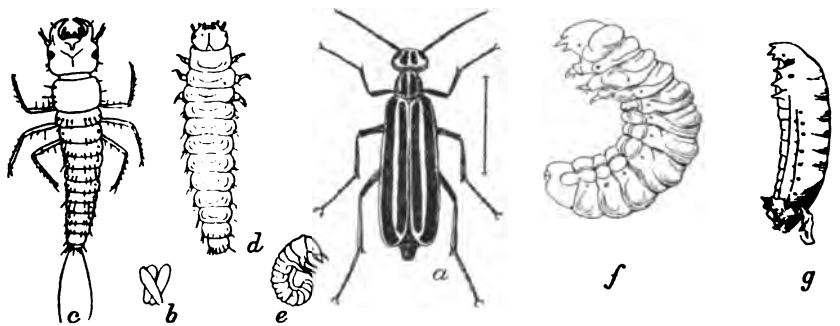

FIG. 13.—*Epicauta vittata: a*, female beetle; *b*, eggs; *c*, triungulin larva; *d*, second or caraboid stage; *e*, same as *f*, doubled up as in pod; *f*, scarabæoid stage, *g*, coarctate larva—all except *e* enlarged (after Riley, except *a*; original, Division of Entomology).

striped is often called the "old-fashioned potato bug." It is abundant and well known east of the Rocky Mountains, of common occurrence on sugar and table beets, and as its life history is typical of injurious forms of this group it may properly receive first attention. The beetle can be easily identified by means of the illustration (fig. 13, *a*). It is about half an inch long, and there are two black stripes on each wing-cover, alternating with yellow.

The eggs are laid in small masses (*b*) on plants or upon the ground. From each hatches a small long-legged larva, called a "triungulin" (*c*), which runs actively about in search of a grasshopper egg pod, which

it enters and devours the contents. After a time it casts its skin and assumes what is termed the "caraboid" or second larval stage (*d*, *e*); and with another molt it resembles a white grub, the "scarabæoid" larval stage (*f*). When a larva has finished its quota of locusts' eggs it undergoes a fourth molt and forms within its own skin what is known as the coarctate larval stage (*g*), and in this condition usually passes the winter. In the spring another larval molt takes place, and with the last shedding of its skin the insect enters upon the true pupal stage, and in due time transforms to a beetle.[a] The pupa of a related species is illustrated in figure 16.

This species also does injury to beans, peas, tomato, turnip, radish, melons, corn, clover, and alfalfa. It was the cause of a serious outbreak in Michigan in the latter part of June and the first part of July, 1900. Corn plants about six inches high and clover suffered severely, the reason being that the potatoes grown there, being all late varieties, had not come up, and more palatable food was not available.

The writer has seen hordes of this species traveling in much the same manner as army worms, and feeding with such voracity that scarcely a beetle flew when plants on which they were congregated were approached. When a "flock" starts to feed on one form of food plant it continues on this until all plants in sight have been devoured, when the beetles have recourse to other plants that are palatable to them. This trait has also been observed in other species, especially in the margined blister beetle.

FIG. 14.—*Epicauta lemniscata*—enlarged (original, Division of Entomology).

THE THREE-LINED BLISTER BEETLE.

(*Epicauta lemniscata* Fab.)

This blister beetle very closely resembles the preceding; in fact, the two are frequently confounded, and injuries inflicted by one species are apt to be attributed to the other. The form under consideration (fig. 14) is a little more slender than the striped blister beetle, has three stripes on each wing-cover instead of two, and is a little longer. It is very abundant southward, and, although perhaps primarily a potato pest like most of our noxious blister beetles, is also extremely fond of beets. During different years we have received complaints of this species and of extensive damage in Florida, South Carolina, and Texas to cabbage, potato, squash, and to beet tops, as also to alfalfa. In the vicinity of Horton, Tex., in 1896, the last-mentioned crop was said to be a failure, owing to the depreda-

[a] Particulars in regard to these peculiar transformations are given in articles by C. V. Riley, Am. Nat., Vol. XII, p. 286; Vol. XVII, p. 790.

tions of this blister beetle. During 1902 we received reports of injuries by it in Florida to tomato, potato, sweet potato, eggplant, turnip, cabbage, cowpea, and beet, beet tops being preferred to all other vegetables.

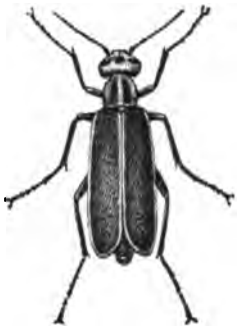

FIG. 15.—*Epicauta marginata*—enlarged (original, Division of Entomology).

THE MARGINED BLISTER BEETLE.

(*Epicauta marginata* Fab.)

One of the commonest Eastern species is the margined blister beetle (figs. 15 and 16). In the writer's experience it appears to be more partial to beets than to any other useful plant. Entire plantings are often seen almost completely defoliated. In a climate like that of the District of Columbia, it occurs so late that no material harm is done, the roots having made nearly complete growth when the insect appears in its greatest abundance, in late July and in August. It is known as an important enemy of beans, potato and tomato, and attacks aster, clematis, and other ornamental plants.

FIG. 16.—*Epicauta marginata*: pupa—enlarged (original, Division of Entomology).

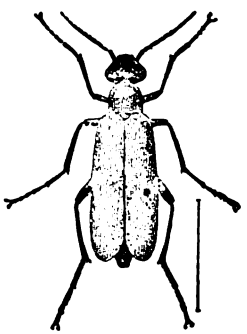

FIG. 17.—*Epicauta cinerea*—about twice natural size (original, Division of Entomology).

THE GRAY BLISTER BEETLE.

(*Epicauta cinerea* Forst.)

This species (fig. 17) is of the same form and general structure as the preceding, but is of a uniform gray color, lacking the sutural and lateral margins which give the name to the margined blister beetle. The habits of the two species are practically identical; in fact, the latter is believed by some to be only a variety of the margined species.

FIG. 18.—*Epicauta maculata*—nearly three times natural size (original, Division of Entomology).

THE SPOTTED BLISTER BEETLE.

(*Epicauta maculata* Say.)

The southwestern portion of the United States is the home of many species of blister beetles not found in the North and East. Among the most abundant of these is the spotted blister beetle (fig. 18). Its body is covered with fine gray hairs, with small rounded areas on the elytra, through which the

natural black of the body shows, giving it the appearance of a gray insect finely dotted with black. It is more or less abundant from Texas and New Mexico northward to South Dakota, and in California and Oregon. It has been known as a beet pest since 1875,[a] and was reported very generally upon sugar beet, potato, and clover in South Dakota in 1897.[b] In August, 1902, Mr. J. L. Webb observed numbers eating leaves of beet at Elmore, S. Dak.

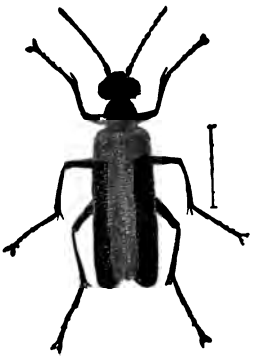

FIG. 19.—*Epicauta pennsylvanica*—enlarged (original, Division of Entomology).

THE BLACK BLISTER BEETLE.

(*Epicauta pennsylvanica* De G.)

The black blister beetle (fig. 19) is a familiar object to nearly everyone from its occurrence on golden-rod, aster, and related wild plants, while the farmer is quite too well acquainted with it as an unwelcome visitor to his potato patch and to various other vegetables. Florists know it under the name of "aster bug," from the severe injuries which it does to asters and which they are unable entirely to prevent. It is uniformly black, without polish, and its length varies from a little more than a quarter to half an inch. It is well distributed in the region east of the Rocky Mountains, and does most injury between the Atlantic States and Texas. Its time of appearance is more or less coincident with the blossoming of the golden-rod, from June to October according to locality, and as a rule it appears later than other species. It is one of the worst insect enemies of potato, beet, and aster, and is also destructive to carrots, beans, cabbage, corn, mustard, clematis, zinnia, and other flowering plants.

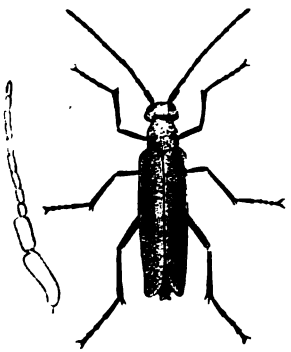

FIG. 20.—*Macrobasis unicolor*: female beetle at right, twice natural size; male antenna at left, greatly enlarged (author's illustration, Division of Entomology).

THE ASH-GRAY BLISTER BEETLE.

(*Macrobasis unicolor* Kby.)

This is one of our commonest Eastern species (fig. 20), and although most destructive to beans, peas, and other leguminous plants, is also a serious enemy of beets, potato, and tomato, and attacks besides sweet potato and some flowering plants.[c]

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[a] Packard, U. S. Geol. Surv. for 1875, p. 731.

[b] D. A. Saunders, Bul. 57, So. Dak. Agl. Ex. Sta., p. 52.

[c] Yearbook U. S. Dept. Agr. for 1898, pp. 249–250.

THE IMMACULATE BLISTER BEETLE.

(*Macrobasis immaculata* Say.)

As with some of the following species, this insect, although common, has not been much studied; but we know of its having injured beets in Kansas as early as 1897, and during 1902 it was destructive to sugar beet in Colorado. Among other food plants are potato, tomato, and cabbage. It is one of our largest blister beetles, and is gray or yellow in color.

THE TWO-SPOTTED BLISTER BEETLE.

(*Macrobasis albida* Say.)

During 1902 this blister beetle was destructive in Indian Territory, in one case devouring a field of sugar beets in a single day. Although an extremely common species from Kansas to Texas and New Mexico, little has been published in regard to its habits until very recently. Like others of its kind it favors vegetable crops, which include tomato, potato, and some others. It is evidently an old beet enemy, as we have record of its being very injurious to this crop in Kansas a decade earlier than the case reported.

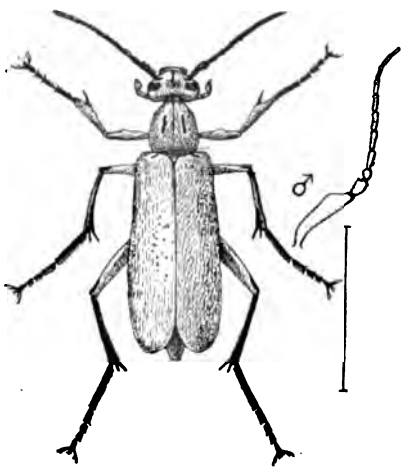


FIG. 21.—*Macrobasis albida:* twice natural size (original, Division of Entomology).

This is also a large species (fig. 21), gray or yellowish in color, with the thorax marked with two nearly parallel lines. It measures about an inch or an inch and a half in length.

THE SEGMENTED BLACK BLISTER BEETLE.

(*Macrobasis segmentata* Say.)

Injury by this blister beetle to beets was reported to this office in 1897, when a considerable proportion of crops of beets, as well as potato, tomato, and cabbage, was being destroyed in Kansas, the beetles being described as coming in large swarms, settling down in fields, and devouring and ruining crops in a few hours. It is one of the larger species of the group, sometimes attaining a length of about an inch. It is of robust form, uniformly dull black, except for an occasional narrow fringe of cinereous hairs on the base or apex of the thorax. Its range extends from Kansas well into Mexico.

NUTTALL'S BLISTER BEETLE.

(*Cantharis nuttalli* Say.)

This species has several times been noted as injuring beets. The beetle (fig. 22) is large and beautiful, usually of a bright metallic green, the head and thorax having a coppery luster, the wing-covers often purple. Its habitat extends from the Mississippi region to the Rocky Mountains and from Canada to Nebraska.[a]

Notes on the habits of this and several other species which have been considered are published in Bulletin No. 40 (new series) of the Division of Entomology (pp. 114–116).

REMEDIES.

Paris green is one of the best remedies for blister beetles when they occur on beets, potatoes, and most other crops. It may be applied dry, mixed with 10 to 20 parts of flour, plaster, or air-slaked lime, or in the form of a spray, also mixed with lime or Bordeaux mixture, at the rate of a quarter of a pound of the poison to 40 gallons of the diluent. Repeated applications are sometimes necessary, since the poisoned beetles are replaced by others.

FIG. 22.—*Cantharis nuttalli:* female beetle, one-third larger than natural size (author's illustration, Division of Entomology).

Owing to the rapidity with which many species work, frequently in swarms of thousands, poisons are of little value. We must, therefore, resort to mechanical measures for their destruction, and in the employment of these promptness and thoroughness are the essentials. A remedy which is employed with success in the Western States consists in sending a line of men and boys through infested fields to drive the beetles before them until they alight on a windrow of hay, straw, or other dry vegetable material which has previously been prepared along the leeward side of the field. When the beetles have taken refuge in such a windrow, it is fired and the beetles are burned. The beetles may be destroyed by sweeping them into a net, such as is used by insect collectors, and throwing the captured insects into a fire; or by beating them into large pans of water on which there is a thin scum of coal oil. The latter remedy is successful over small areas.

After what has been said concerning the voracity of these beetles it is almost superfluous to add that whatever remedy is employed should be applied at the outset of attack in order to be of substantial value.

[a] Yearbook U. S. Dept. Agr. for 1898, pp. 250–251.

SNOUT-BEETLES OR WEEVILS.

A few species of snout-beetles or weevils have been observed attacking sugar beet at various times, but with the exception of the imbricated snout-beetle these insects are of little importance as beet pests; in fact, only one species other than that habitually does material harm to beet plants. The species in question (*Tanymecus confertus* Gyll.) was once notably injurious to sugar beet in Nebraska. It was observed by Professor Bruner first on cocklebur, lambsquarters, and smartweed, after devouring which it completely destroyed the beets in a 12-acre field. Injury by this class of insects in beet fields is by the beetles, the larvæ feeding on the roots of weeds and wild plants.

THE IMBRICATED SNOUT-BEETLE.

(*Epicærus imbricatus* Say.)

The imbricated snout-beetle is a common insect of the field, garden, and orchard, and capable of committing considerable injury to a variety of useful plants including sugar beet and various other vegetables, such as beans and pease.

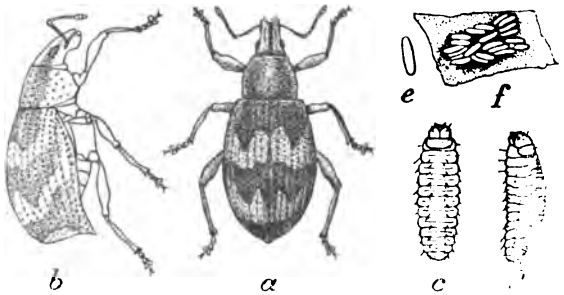


FIG. 23.—*Epicærus imbricatus*: *a*, female beetle; *b*, same from side; *c*, newly hatched larva; *d*, same from side; *e*, egg; *f*, egg mass.—*a*, *b*, about three times natural size; *f*, two times; *c*, *d*, *e*, more enlarged (author's illustration, Division of Entomology).

It is one of our largest snout-beetles, measuring nearly half an inch in length, and has the body covered with minute imbricated scales (whence the insect's name), the lighter portions appearing brownish gray, and the darker light brown, forming a pattern as shown in figure 23, *a*, and *b*. The head is prolonged into a short broad snout, with elbowed antennæ and the elytra or wing covers terminate in a point. Both sexes are wingless.

It is well distributed, occurring in most States, except the more northern ones, east of the Rocky Mountain range. It does not appear to be found north of the Upper Austral life zone. This distribution includes localities from the neighborhood of New York City southward to Texas and westward to Colorado and Utah.

In addition to the plants that have been mentioned as furnishing food for this species, it has been observed doing more or less injury to onion, radish, cabbage, cucumber, watermelon, muskmelon, squash, corn, potato, and tomato, among vegetables; apple, cherry, and pear trees; raspberry, blackberry, and gooseberry bushes; and to feed on grasses and clover, and some forms of weeds.

The larva is subterranean in habit, but the mature larva and the pupa are unknown, as is also the larval food plant. A female beetle kept by the writer from May till July deposited eggs almost daily, 540 in number, and it was not known how many eggs had been laid prior to that time. The beetle possesses the habit so common to snout-beetles of "playing 'possum" or feigning death when disturbed, dropping off its food plant on the slightest disturbance and remaining for some time before resuming activity.[a]

A beetle parasitized by a fungus (*Sporotrichum globuliferum?*) is illustrated in figure 24.

The imbricated snout-beetle is one of many species of insects which are sporadic as regards injurious attack and troublesome only in seasons following a year which has been favorable to the increase of individuals. The beetles are not restricted to wild plants even in years of scarcity, but are found over the area which they inhabit on cultivated or other useful plants every year. Fortunately the beetle is not only irregular as to destructive occurrences, but is omnivorous as well, subsisting on one plant quite as well as another, thus distributing attack.

FIG. 24.—*Epicærus imbricatus:* beetle attacked by fungus—three times natural size (author's illustration, Division of Entomology).

Remedies.—This species will yield to the same remedies in use against the Colorado potato beetle. On plants resistant to arsenicals, such as potato, Paris green applied as a spray at the rate of a pound to 100 gallons of water is effective, while on less resistant plants, such as peach and bean, a weaker spray—about 1 pound to 150 gallons of water—or one in which arsenate of lead is the poison, is necessary to avoid scalding the foliage. Arsenicals can also be used dry, mixed with about 10 parts of cheap flour or lime, and applied to the infested plants by means of a hand bellows.

The beetles may be readily dislodged from affected plants by jarring them with a pole or stick upon "curculio catchers" of strong cloth stretched on frames and mounted on wheels or runners. If the cloth is saturated with kerosene, it will kill them; or, as they make little or no effert to escape, they may be easily taken from the "catchers" and killed by burning or by pouring scalding water over them.

Eventually this snout-beetle will probably become rare owing to its being wingless, when it may be replaced by other species having well developed wings.

[a] A more detailed account is given in Bul. 19, n. s., Div. Ent., pp. 62–67.

CUTWORMS.

These insects are among the most troublesome with which the vegetable grower has to deal, but, although often associated with injury to sugar beet, they as a rule show no preference for this plant. Hence they are of little importance save under exceptional circumstances, when they attack newly planted crops. They are usually present in most gardens and fields, and it is a question of their appearance in numbers and at the time of the year when the plants are just beginning to grow, as to whether they will prove sufficiently destructive to require remedial treatment. They are likely to attack any portion of a beet plant—foliage, flowers, stalks, fruits, or roots—and when they are sufficiently abundant to migrate like army worms they can be quite injurious.

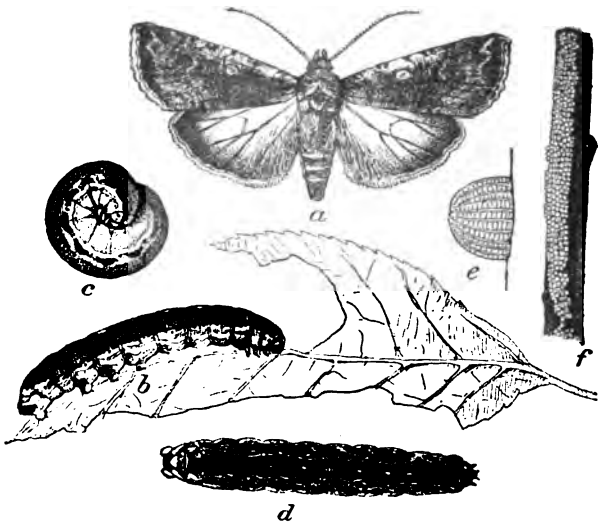


FIG. 25.—*Peridroma margaritosa:* *a*, moth; *b*, normal form of larva, lateral view; *c*, same in curved position; *d*, dark form, dorsal view; *e*, egg from side; *f*, egg mass on twig (after Howard, Division of Entomology).

Although we have two or three score of injurious cutworms, not more than half a dozen of these have been reported to be seriously troublesome to sugar beet. The different species vary considerably as to life and other habits, but in this connection brief mention will be made of only a few of the most important insects of this group.

THE VARIEGATED CUTWORM.

(*Peridroma margaritosa* Haw. [*saucia* Hbn.].)

There is little doubt that this is the most important and widely known of all cutworms. It is cosmopolitan and likely to be found anywhere, and although it favors vegetable crops it is able to eke out an existence on almost any form of vegetation. The progenitor of this cutworm is a rather large grayish-brown moth or "miller," and the full-grown cutworm measures about 1¾ inches. It is variable, like the moth, some forms being pale and others darker. The usual ground color is rather dull brown, mottled with gray and smoky black above, the characteristic feature consisting of a row of four to six yellow

medio-dorsal rounded spots. The different stages are shown in figure 25. During the severe outbreak of this species in 1900, already mentioned, practically all forms of vegetables, including sugar and table beets, were attacked, the insect even eating into roots and tubers and devouring the foliage and gnawing the bark of trees.

A detailed account of this species is furnished in Bulletin 29, new series, Division of Entomology.

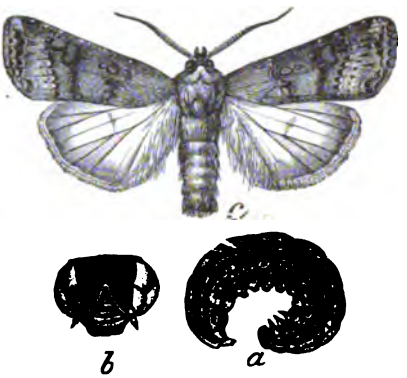


FIG. 26.—*Agrotis ypsilon*, a beet cutworm: *a*, larva; *b*, head of same; *c*, adult—somewhat enlarged (fom Howard, Division of Entomology).

THE GREASY CUTWORM.

(*Agrotis ypsilon* Rott.)

This species is commonly found in fields of beets, and may be selected as typical of its class. In importance as a pest it is perhaps second only to the variegated cutworm. It is of about the same size (fig. 26), and of a dull, dirty brown color, characteristic of most cutworms, with the lower portion paler and greenish, and the entire surface of a greasy appearance, whence the name. It is cosmopolitan, and has a most emphatic and pernicious cutting habit. It is especially troublesome to newly set tomato plants, to potato, corn, lettuce, and tobacco.

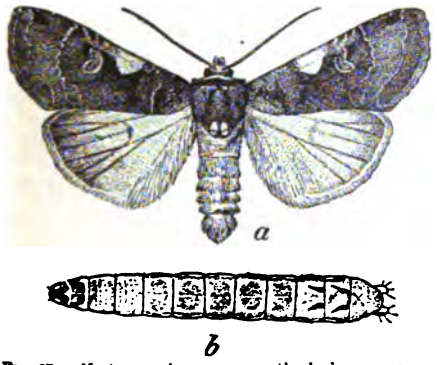


FIG. 27.—*Noctua c-nigrum: a*, moth; *b*, larva—somewhat enlarged (author's illustration, Division of Entomology).

THE SPOTTED CUTWORM.

(*Noctua c-nigrum* Linn.)

This is one of our commonest and most destructive species, and is commonly found on beets. It resembles the variegated cutworm in being cosmopolitan, nearly omnivorous, a climbing species, and in migrating in numbers like the army worms. The moth (fig. 27, *a*) has brown forewings, tinged with red or purplish and marked with lighter colors as figured. The cutworm (*b*) is pale brown or gray, sometimes whitish with greenish or olive tints, and has the last segments marked with oblique black lines. It measures, fully extended, about an inch and a half. The principal crops which it has been known to injure include, besides beets, corn, and other cereals, cabbage, cauliflower, turnip, pea, carrot, tomato, celery, rhubarb, currant, gooseberry,

clover, violets and some other ornamental plants. It has been noticed attacking grasses and oats, but does not appear to resort to these plants when more choice food is at hand.

THE WESTERN ARMY CUTWORM.

(*Chorizagrotis agrestis* Grote.)

In 1897 this cutworm, which had hitherto led an unpretentious existence in the Missoula Valley, Montana, developed in great numbers, and a serious outbreak followed. According to the account given by Dr. E. V. Wilcox (Bul. 17, Montana Agl. Exp. Sta., 1898), this visitation resembled that of the common army worm, and the list of observed food plants shows that it can be a very serious vegetable pest, since, besides beets, it attacks cabbage, horse-radish, radish, mustard, turnip, pea, tomato, potato, onion, celery, rhubarb, corn, cereals, grasses, clover and other forage crops, forest and fruit trees, and bush fruits.

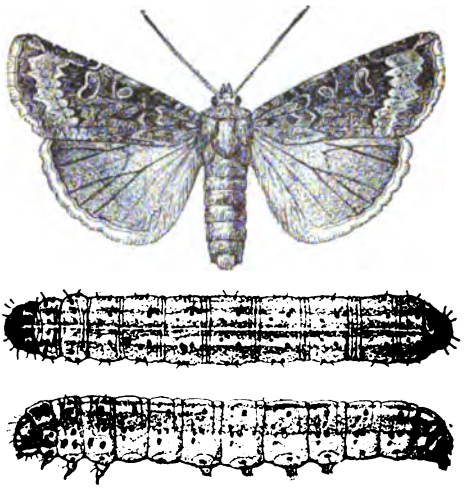


FIG. 28.—*Chorizagrotis agrestis:* moth above; larva, dorsal view, in center; larva, ventral view, below—somewhat enlarged (original, Division of Entomology).

This cutworm (fig. 28) is of the ordinary type, and attains a length of 2 inches when mature. Its body is nearly smooth, only a few short hairs being observable. The color varies from pale green to dark brown. Along the sides there are alternating longitudinal light and dark bands. The moth is brown with gray markings, has a wing expanse of about 1¼ inches, and is quite variable.[a]

The recorded distribution comprises Kansas, Nebraska, Texas, New Mexico, Arizona, Colorado, Montana, and California.

Although the injuries committed in 1897 have not to our knowledge been duplicated, reports have reached us of the occurrence of great numbers of the species in widely separated localities, the moths flying about in such numbers as to become annoying pests in dwellings. Such reports were received from Missouri in 1902, and from Arizona and Colorado in 1903. In Montana a "wild sunflower" (*Balsamorrhiza sagittata*) and avens (*Geum triflorum*) are favorite food plants, but in other localities it seems probable that the natural

[a] This species is so often accompanied by two related forms, more particularly by *Chorizagrotis introferens* Grote, as to give rise to the supposition that all are colorational varieties of the same species, the truth of which will probably be established by rearing from selected females.

food, as with so many other forms of cutworms, consists of wild grasses of little or no value, and when grasses or weeds are replaced by crops these are apt to be attacked, under favoring conditions.

THE COTTON CUTWORM.

(*Prodenia ornithogalli* Guen.)

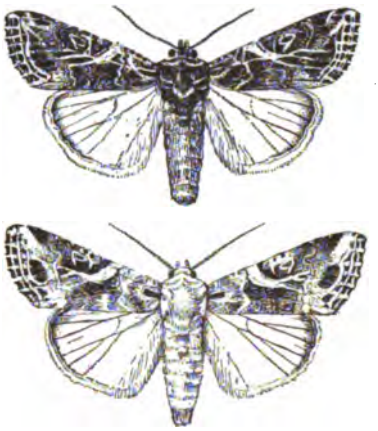


FIG. 29.—*Prodenia ornithogalli:* dark form, male, above; pale form, female, below—somewhat enlarged (original, Division of Entomology).

This species, although called a cutworm, has little in common with preceding species, being more distinctly marked, more or less diurnal in habit, and in having the cutting trait somewhat feebly developed. In fact, it more nearly resembles the boll worm in its habit of boring into the bolls of cotton and the fruit of tomato. It is a very common species, but as a rule not especially destructive, as it is more solitary than the common cutworms. It has been observed attacking and doing more or less injury to beets, potato, asparagus, cabbage, cucumber, peach, and cottonwood. It is also common on violet, morning-glory, and other ornamental plants, and on weeds, and is frequently found in greenhouses.

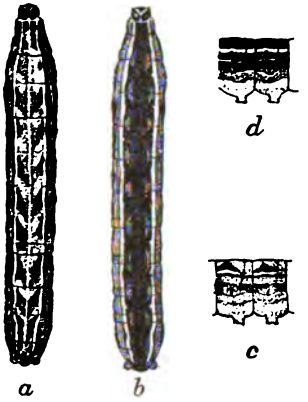


FIG. 30.—*Prodenia ornithogalli:* *a*, pale form of larva; *b*, dark form of same; *c*, lateral view of abdominal proleg segments of pale form; *d*, same of dark form—all enlarged (original, Division of Entomology).

The moth has a wing expanse of a little less than 1½ inches, and is quite distinct from any which have already been considered, the fore-wings having a more complicated pattern. There is much variation in the colors, which has caused differently colored varieties to be described as species. Two extreme forms are shown in figure 29. That they are mere colorational varieties of one species has been proved by the writer by rearing both from an egg mass deposited by a single female (Bul. 27, new series, Div. Ent., pp. 64–73, 114).

The larva is subject to the same variation as the moth. The ground color is generally olive or greenish brown, finely lined with dark gray and brown, while the upper surface is ornamented with a double row of velvety black or greenish spots, which give it a striking appearance. A pale form of the larva is shown in figure 30 at *a* and a darker form at *b*. It is a singular fact that in the writer's experiments the pale larva produced the dark form of moth and the dark larva the

lighter moth. The distribution of this species is wide, including the territory from Massachusetts to the Gulf, and westward to California, but it occurs in greater numbers southward. In the northern portion of its range it is occasionally killed off by exceedingly cold winter temperatures, as happened in 1899. The larvæ are found abroad from April to November. As with other species which have apparently come northward from the Gulf region, this species is most destructive in the autumn of the year. It is credited with being double-brooded, and possibly three generations are produced in the South. Larvæ have been observed by the writer to complete their development in a month, and the pupal period varies from 12 to 25 days. The winter is evidently passed in the pupal condition, in which respect this species differs from the ordinary cutworm.

THE GREEN BEET LEAF-WORM.

(*Peridroma inciris* Guen.)

In certain years and localities, as in Illinois in 1899 and 1900, this species is more abundant on beet leaves than any other caterpillar. It feeds on both surfaces of a leaf, and has been observed eating purslane, which is doubtless its natural food plant.

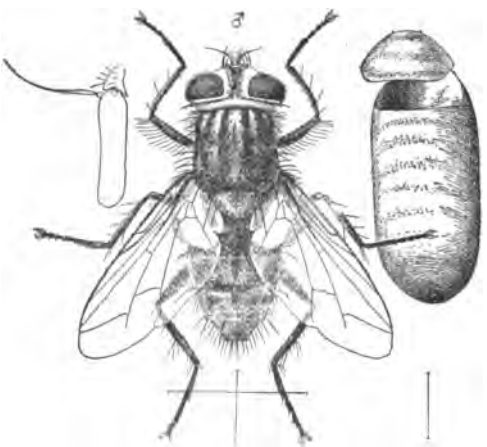


FIG. 31.—*Euphrocera claripennis*, a common cutworm parasite: adult with puparium at right and enlarged antenna at left (from Howard, Division of Entomology).

The larva, also called green cutworm, is green with a white or pinkish stripe on each side of the body. The species is generally distributed, and quite common in Illinois and Kentucky, where it is apparently double-brooded.

NATURAL ENEMIES.

Cutworms are exposed to a great variety of natural enemies, but as a rule these are not efficient checks except when the cutworms appear in great numbers and travel like the army worms. At such times many species of predaceous and parasitic insects and predatory mammals and birds, wild and domestic, destroy them in great numbers. Of the predaceous enemies ground beetles are most abundant, while the parasites include numerous species of ichneumon and tachina flies and a few chalcis flies. A common species of tachina fly is shown in figure 31. Cutworms are also subject to a fungous disease *Empusa aulicæ*. Among birds which are beneficial by feeding upon cutworms are robins, crows, the bluebird, and the bluejay, and among domestic animals are chickens, ducks, turkeys, Guinea fowls, and hogs.

METHODS OF CONTROL.

From what has been said of the utility of domestic fowls and other animals it is obvious that with proper judgment their services would save great losses that it might otherwise be difficult to avert.

Poisoned baits are the standard remedies against cutworms, and to be most effective they should be applied as soon as attack is noticed. They are particularly valuable in cases where the direct application of insecticides to a plant is impossible owing to the danger of poisoning persons or stock when it is used for food. There are two kinds of bait—fresh vegetable and bran mash.

Vegetable bait may be prepared as follows: Spray a patch of clover, pigweed, or some useless succulent plant that grows by the roadside or in fence corners, with Paris green, 1 pound to 150 gallons of water; mow it close to the ground, and place it while fresh in small heaps about the infested plants at intervals of a few feet. The later in the day this can be done the better, as the material keeps fresh longer and the cutworms feed almost exclusively at night. Owing to the wilting of this bait, particularly in dry, sunny weather, it is advisable to cover each heap with a chip, shingle, or bit of bark for its protection against the sun's rays.

Bran mash or bran-arsenic mash is of equal value to a fresh vegetable bait, and, according to some, still more efficacious. Paris green, arsenoid, white arsenic, or in fact any arsenical can be used for poisoning this bait, and in its preparation, on account of the weight of the poison and the fact that it soon sinks to the bottom of the water when stirred, it is best first to mix the bran with water and sugar and then add the poison. The proportions are 2 or 3 ounces of sugar or a similar quantity of glucose or molasses to a gallon of water and a sufficient amount of bran (about a pound per gallon) to make, when stirred, a mixture that will readily run through the fingers.

Before planting a crop it is advisable to employ such bait, and its perfect success is assured by having the ground bare, which practically compels the cutworms to feed upon it.

Bordeaux mixture.—This fungicide has been recently tested against the variegated cutworm upon potato vines and asparagus. It was sprayed on as a remedy for blight, and it was discovered that the plants thus treated were free from attack. The use of this fungicide as a cutworm deterrent is certainly advisable. In any case, it should be used as a diluent for whatever arsenical is used.

Hand methods.—On some plants it is next to impossible to apply any but hand methods with good results. Experiments in Washington State during the season of 1900 demonstrated conclusively that in some cases it required less time to shake or brush cutworms from affected plants than to destroy them by spraying or otherwise.

"*Back firing*," a somewhat old-fashioned practice, is of great use in destroying army worms, cutworms, and other forms of insects when they occur in such numbers as to ruin a crop. It consists in burning a rather wide stretch in advance of the wind at the farthest extremity of the field, and then stamping this out to prevent the fire from reaching other fields beyond. The field is then burned, beginning with the side from which the wind is blowing. This has the effect of destroying the entire field, with all the cutworms and many other insects which it contains, with practically no danger of the fire spreading to fields where it is not desired.

When cutworms assume the habit of traveling in armies they should be treated in the same manner as advised against the army worms.

ARMY WORMS.

In addition to the army cutworm that has been mentioned and the variegated and spotted cutworms, which sometimes exhibit the same migratory tendency, there are three important species of beet-feeding caterpillars, allied to the cutworms, but lacking the true cutworm habit. The most important of these is the beet army worm.

THE BEET ARMY WORM.

(*Caradrina* [*Laphygma*] *exigua* Hbn.)

In the year 1899 this species, which had not previously attracted attention by its ravages, became prominent as an enemy to the sugar beet in Colorado. Subsequent study showed that it had been observed at an earlier date attacking crop and other plants in New Mexico and in California. It is an imported pest, and, although not at the present time of great importance, bids fair, in course of time, to become a serious enemy to the cultivation of sugar beet in America. It has evidently come by way of California and is traveling eastward, a method of migration of which there is precedent in the Colorado potato beetle.

The moth (fig. 32, *a*) is mottled gray, resembling the plain form of the related fall army worm. The fore-wings are broader and paler, and the reniform and other markings are more distinct. The wing expanse is less than an inch and one-half. The larva is rather slender, with a small head, and the body greenish or olivaceous and striped as shown (fig. 32, *b*, *c*, and fig. 33).

When migrating, the beet army worm attacks several forms of vegetation. Sugar beet appears to be the favorite host plant; table beets are also relished, and it feeds quite as well on lambsquarters, pigweed, and saltbush (Atriplex). When numerous, corn, potato, pea, onion, sunflower, and the leaves of apple, mallow, *Nicotiana glauca*, Cleome, plantain, and wild grasses are eaten. In southern California the moths appear in April and until June; caterpillars of the first generation

develop as early as the last week of May and a month later in June. In the cooler climate of Colorado and New Mexico larvæ have been noticed about the middle of June, becoming more abundant in August, when the greatest damage is done. From our somewhat incomplete knowledge of this species it appears that it has a spring and late autumn generation in Colorado and New Mexico, and perhaps a third in southern California, and it is evident that the second generation is generally most destructive.[a]

Methods of control.—Several remedies have been employed in Colorado with satisfactory results. These include Paris green and kerosene emulsion, both of which killed the insects and checked their numbers for the following year. Paris green was applied as a spray and dry, mixed with flour. With flour it cost about 80 cents an acre.

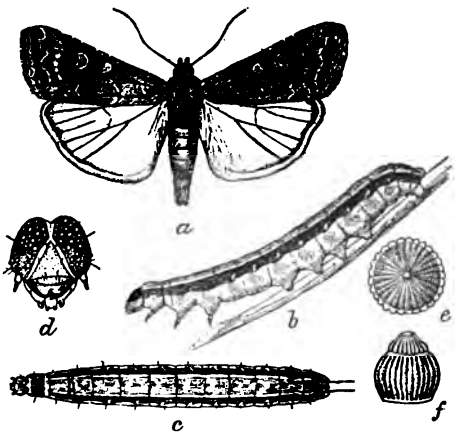


FIG. 32.—*Caradrina exigua:* *a*, moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, head of larva; *e*, egg, viewed from above; *f*, egg, from side—all enlarged (*c*, *f*, after Hofmann; *a*–*d*, after Chittenden, Division of Entomology).

Two sprayings with the liquid preparation were most effectual. When this species is unduly abundant it should be treated in the same manner as the fall army worm (*Laphygma frugiperda* S. & A.), which is quite often associated with injury to sugar beet. The latter attacks nearly all forms of vegetable and other crops, but as it is discussed fully in Bulletin 29, new series, Division of Entomology, further mention is unnecessary here.

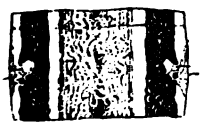


FIG. 33.—*Caradrina exigua:* enlarged section of first proleg segment, dorsal view (original, Division of Entomology).

A third species, the true army worm (*Leucania unipuncta* Haw.), is more strictly an enemy of cereals and grasses, and not, as a rule, of much importance as a beet feeder. Remedies are considered in Circular No. 4, Division of Entomology, and short general accounts of both the true army worm and the fall army worm are furnished in Farmers' Bulletin 132.

WEBWORMS.

Among insects that are nearly always to be found in their natural habitat in fields of beets are two small caterpillars known as webworms. Of these the sugar-beet webworm is a prime beet pest, and the second, known as the garden webworm, is a general feeder, devel-

[a] In a more complete consideration of this species, Bul. 33, new series, Div. Ent., pp. 37–46, references to economic articles by C. P. Gillette and others are furnished.

oping on weeds related to beets and invading cornfields and vegetable gardens when the supply of wild food plants and weeds is scant. Still a third species, the imported cabbage webworm, occasionally occurs on beets, but, as its name indicates, it is a cabbage pest, properly speaking, and does not resort to other plants when Cruciferæ are available.

THE SUGAR-BEET WEBWORM.

(*Loxostege sticticalis* Linn.)[a]

Although primarily a sugar-beet insect, this species, like many others that have been treated, is a periodical pest, and, as it is an introduction from abroad and widening its range, there is likelihood that it will in time assume greater economic importance. It is cousin to the native garden webworm, but the moth is larger, darker colored, and the markings are somewhat more pronounced. With the

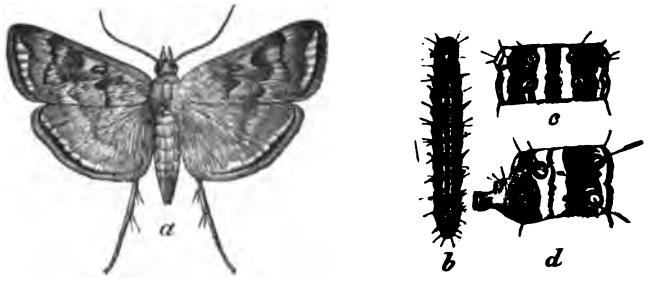


FIG. 34.—*Loxostege sticticalis: a*, moth, twice natural size; *b*, larva, less enlarged; *c*, upper surface of first proleg segment of larva; *d*, side view of same; *c*, *d*, more enlarged (reengraved after Insect Life, Division of Entomology).

wings fully expanded it measures nearly an inch and is of a purplish brown color, with darker and paler bands, as shown in figure 34, *a*.

The pale-yellow eggs are laid singly or in rows of two to five or more, overlapping like scales. The young webworms are whitish, with polished black head and piliferous spots. Mature caterpillars (*b*) are darker than the garden webworm, with a preponderance in longitudinal markings.

It is an inhabitant of western and central Europe and northern Asia, and has evidently, like the beet army worm, been introduced from the Orient on the Pacific coast, and is now slowly but steadily pushing its way eastward. In 1869 it came under observation in Utah, and by 1873 had found its way to Missouri. It occurs southward to Kansas and as far north and east as Michigan, but the major portion of reported injuries have occurred in Kansas and Nebraska.

Practically all that is known of the biology of this webworm is from

[a] Riley & Howard, Insect Life, Vol. V, pp. 320–322; Vol. VI, pp. 369–373; Chittenden, Bul. 33, new series, pp. 46–49.

data accumulated by the Department of Agriculture. The life history has not been followed throughout, but two generations have been differentiated, and possibly a third is produced in the most southern region which the insect inhabits, the moths from which issue in autumn. Where observed in Nebraska there was a short-lived July generation, requiring only two weeks between the maturity of the caterpillars and the appearance of the moths, which coupled and deposited eggs for another generation. The caterpillars of the July brood transform to pupæ almost immediately after entering the ground, but the last generation remains as larvæ for some time before assuming the chrysalis stage. A wild food plant, pigweed or careless weed (Amaranthus), has been observed, and it has been noticed also that injury to fields of sugar beet are most observable where the ground had been allowed to run to this wild plant. In Europe it lives on another pigweed (Artemisia). A parasitic enemy of this species is illustrated in figure 35.

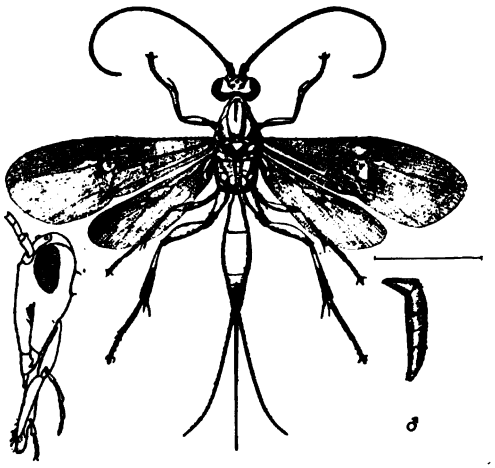


FIG. 35.—*Agathis* (*Cremnops*) *vulgaris:* female, head at left; abdomen of male, side view, at right—enlarged (redrawn after Insect Life, Division of Entomology).

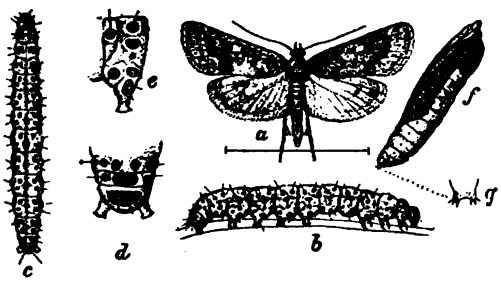


FIG. 36.—*Loxostege similalis:* *a*, male moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, anal segment; *e*, abdominal segment, lateral view; *f*, pupa; *g*, cremaster—*a*, *b*, *c*, *f*, somewhat enlarged; *d*, *e*, *g*, more enlarged (reengraved after Riley, except *c*, original, Division of Entomology).

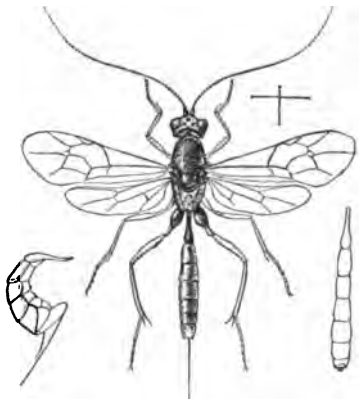
THE GARDEN WEBWORM.

(*Loxostege similalis* Gn.)

The garden webworm has the same natural food plant (Amaranthus) as the sugar-beet species, but is native to America, and although widely distributed is somewhat restricted as regards important injuries to the South and Middle West, particularly in States between the Mississippi Valley and the Rocky Mountain region. In 1885 it was the cause of serious trouble over a large area, including five States and Indian Territory.[a] It is a general feeder, and attacks most vegetables, cereals, grasses and other forage crops, as also tobacco

[a] Rept. Comm. Agr. for 1885 (1886), pp. 265–270.

and sugar-cane, but its injuries are most pronounced on corn and cotton. The moth (fig. 36, *a*) is variable from yellow to buff, and there is variation in the degree of markings of the fore-wings. The expanse is about three-fourths of an inch. The larva (*b*, *c*) is also variable, the ground colors running through pale and greenish yellow to dark yellow. It seems probable that, as two generations have been observed in the Middle States and three in the South, the life history of this species is not materially different from that of the beet webworm. Eggs are deposited on lower surfaces of leaves, and the caterpillar, soon after hatching, draws together the edges of a leaf by means of its web, or fastens together two contiguous leaves, forming a shelter, from which it crawls forth to feed. A parasite of this species is shown in figure 37.



♀ ♂

FIG. 37.—*Limneria curycreontis:* adult female; ♀, abdomen of female, lateral view; ♂, abdomen of male, dorsal view (after Insect Life, Division of Entomology).

Remedies.—Paris green applied as a spray has been used with perfect satisfaction against both of these webworms, the fact that they are more or less surrounded by webs and leaf tissues offering little or no barrier to the effects of the poison. In addition, clean cultural methods, including late plowing in the fall followed by deep plowing in spring, and the burning of all waste material and weeds, are of service in controlling these pests. Early planting is also useful as a safeguard for some crops.

MISCELLANEOUS CATERPILLARS.

In addition to the caterpillars which have been mentioned—cutworms, army worms, and webworms—a number of other forms of different classes and with varying habits are so frequently found in beet fields as to deserve consideration. The first two that will be mentioned are naked caterpillars; the last two are hairy caterpillars, or woolly bears, as they are familiarly termed.

THE WHITE-LINED MORNING SPHINX.

(*Deilephila lineata* Fab.)

An illustration and short account of this species, known also as the purslane sphinx, is presented, because it is frequently found in beet fields and evinces an apparent preference for beet among cultivated plants. From its very large size it might be judged a pest of importance. On the contrary, it feeds naturally on purslane, seeming to

injure beets only when the former plant is exhausted or unavailable. Occasionally it occurs in some numbers, as has happened in several localities in the past three years, and then may attack various other useful plants, among which turnip, watermelon, buckwheat, grape, and the leaves of apple have been recorded. During 1900 Mr. Edward C. Post reported injury to sugar beets at Dundee, Mich., and Mr. T. Lytle, Manzanola, Colo., reported damage to tomatoes and to apple and prune trees.

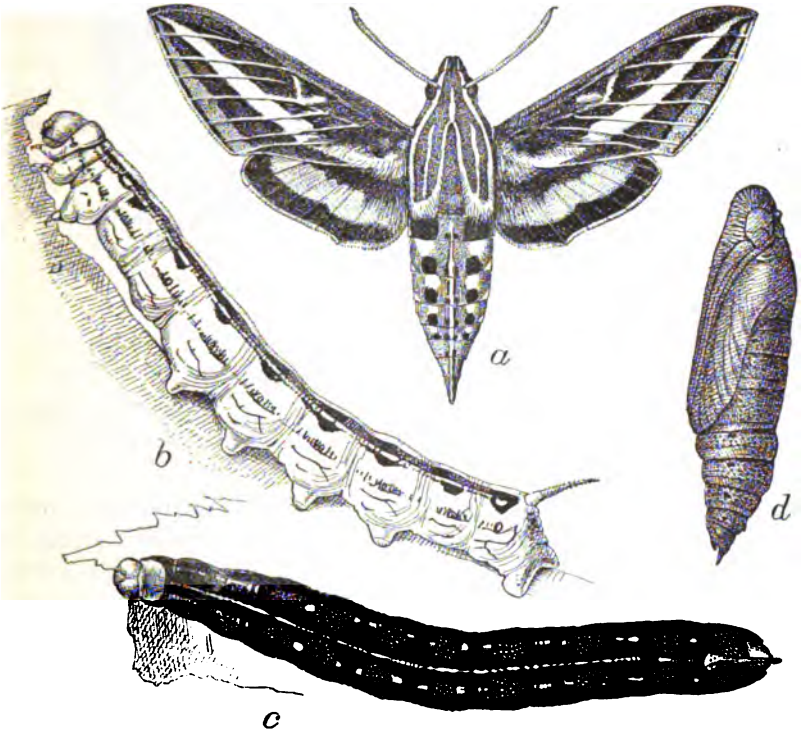


FIG. 38.—*Deilephila lineata: a*, moth; *b*, pale larva; *c*, dark form of larva; *d*, pupa—all natural size (original, Division of Entomology).

The resemblance of the adult (fig. 38, *a*) to a humming bird is marked particularly when the insect is in flight. It will be noted that there are two forms of the caterpillar, a light one (*b*) and a dark one (*c*). The insect belongs to the same group as the more familiar tomato and tobacco worms, and its life habits are somewhat similar.

Remedies.—On account of the large size of this insect it is not difficult to control it by picking the young caterpillars from the plants and destroying them. They also succumb to the arsenicals.

THE ZEBRA CATERPILLAR.

(*Mamestra picta* Harr.)

The zebra caterpillar is a conspicuous garden pest, particularly attached to vegetables, showing some preference for beets and spinach,

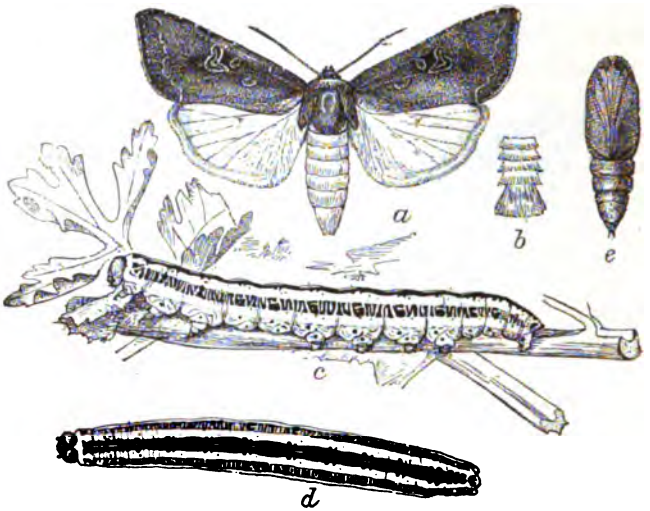


FIG. 39.—*Mamestra picta: a*, female moth; *b*, abdominal segments of male moth; *c*, pale form of larva, lateral view; *d*, larva, dorsal view; *e*, pupa—all somewhat enlarged (original, Division of Entomology).

cabbage, celery, peas, and asparagus, and feeding at times on nearly all forms of vegetation, including cereals, weeds, and the foliage of trees. As previously mentioned, it bears the distinction of being the first insect reported to affect beets in this country. The moth (fig. 39, *a*) resembles in general contour the progenitors of cutworms belonging to the same group of insects. It has a wing expanse of about an inch and a half; the fore-wings and thorax are brown, shaded with darker purplish brown, and the hind-wings are white, tipped with pale brown at the margins. The larva or caterpillar (fig. 39, *c*, *d*) is somewhat variable, but the head is red and the ground color yellow, more or less strongly marked with black, the stripes on the sides suggesting the name of zebra caterpillar. The larva when first hatched from the egg is dull gray and looks quite unlike the mature form. Two views of the newly hatched larva are presented in figure 40, *a*, *b*, while the third stage is shown at *c*.

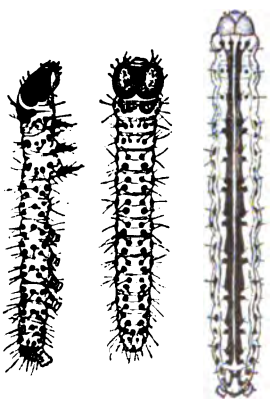


FIG. 40.—*Mamestra picta: a*, *b*, newly hatched larva; *c*, larva of third stage—much enlarged (original, Division of Entomology).

This species is quite abundant in the North, becoming most trouble-

some in the second generation, which usually appears in September. In addition to the plants that have been mentioned as furnishing food for the zebra caterpillar are cauliflower, turnip, beans, carrot, potato, corn, currant, cranberry, willow, roses, and others. The winter is passed in the pupal condition, and the moths appear in May and June. The first eggs hatch in a moderate temperature in six days, and the larval period is about five weeks. The pupal period is very long, lasting, as observed by the writer, sixty-seven days, making in all a period of one hundred and ten days from the time the eggs were laid until the moths appeared, late in August. This species can endure a considerable amount of cold, but is very susceptible to parasitic attack, and to a less extent to fungous diseases.

Methods of control.—The caterpillars when first hatched are gregarious, hence easily discovered at this time and destroyed by hand or by poisons. They yield readily to sprays of arsenicals, but these are not necessary in ordinary cases of attack.

THE SALT-MARSH CATERPILLAR.

(*Leucarctia acræa* Dru.)

Several forms of hairy caterpillars, such as the yellow bear (*Spilosoma virginica*), of similar appearance and habits, are commonly found on sugar beet. One of these, known as the salt-marsh caterpillar

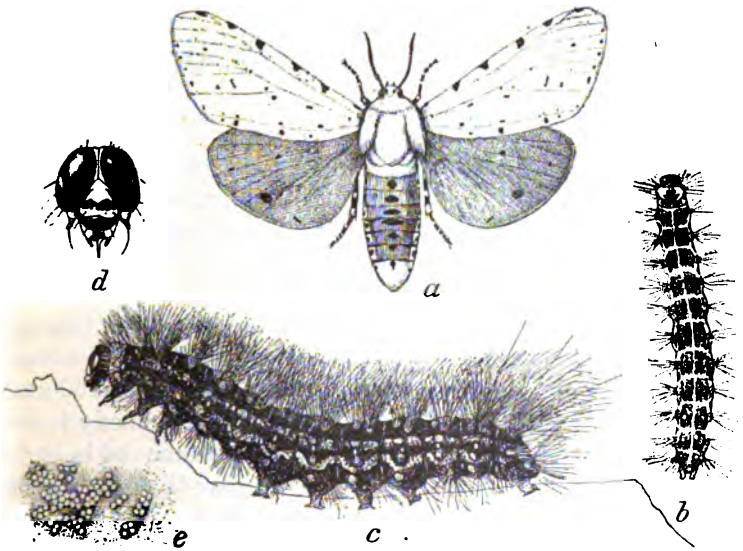


FIG. 41.—*Leucarctia acræa:* *a*, female moth; *b*, half-grown larva; *c*, mature larva, lateral view; *d*, head of same, front view; *e*, egg mass—all slightly enlarged except *d*, more enlarged (original, Division of Entomology).

(*Leucarctia acræa* Dru.), from its ravages early in the past century upon forage crops grown in the salt marshes of New England, is occasionally troublesome in beet and corn fields and in gardens.

This caterpillar differs from the common yellow bear in having a darker body, and the sides are distinctly ornamented with yellow markings. The two species are of about the same length, and the hairs present a similar variation in color. A young larva is illustrated at figure 41, *b*, a mature one at *c*. The moths also closely resemble each other, but the fore-wings of the present species are strongly marked with black, and the abdomen, with exception of the first and last segments, is bright ocher above, with black markings. In the female the hind-wings are white, like the fore-wings, and similarly marked with black, but in the male they are ocher with two black dots (fig. 41, *a*). The life economy of these species is very similar; they form the same sorts of cocoons and transform in any convenient place where shelter can be obtained. In New England the salt-marsh caterpillar is credited with having a single generation, but a little farther south, in the Middle States, two generations have been recognized.

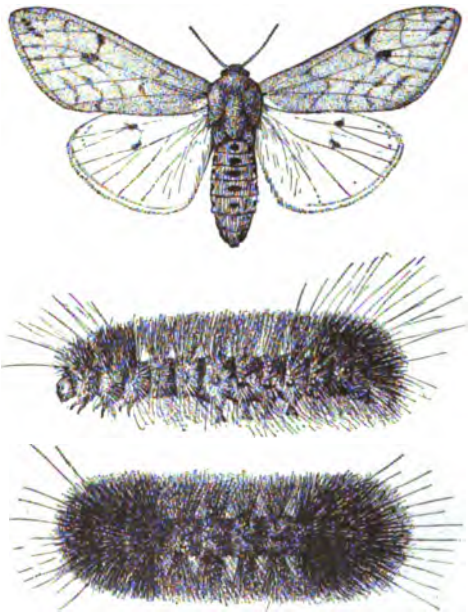


FIG. 42.—*Isia isabella:* male moth above; caterpillar, side view, in middle; dorsal view at bottom—somewhat enlarged (original, Division of Entomology).

THE HEDGEHOG CATERPILLAR.

(*Isia* [*Pyrrharctia*] *isabella* S. & A.)

Another conspicuous caterpillar known to attack beets is shown in the accompanying illustration (fig. 42). It is recorded also as affecting peas and corn, but appears to prefer plantain and other weeds, such as dandelion and burdock. The general color of this caterpillar is bright cinnamon red and usually each end is black. The long hairs with which the body is covered are so evenly distributed as to give it the appearance of being shorn or cropped. The name of hedgehog caterpillar is derived from the habit of this insect of rolling up when disturbed and of passing the winter under the bark of trees or in some similar location rolled up like a hedgehog. The life history of this insect is very similar to that of the preceding. The moth (fig. 42) is dull orange, with the fore-wings marked with dusky stripes, both the fore and hind-wings being spotted with black, the latter a little paler than the others.

Remedies.—As a rule neither this insect nor the salt-marsh caterpillar occurs in troublesome numbers; hence remedies are not often necessary. It can be controlled by ordinary methods of spraying and hand picking.

GRASSHOPPERS, CRICKETS, AND RELATED INSECTS.

Of great economic importance in the West, and in some seasons in other regions, are numerous species of locusts, popularly termed grasshoppers. Several forms of related insects, such as katydids and crickets, are also injurious, but all of these insects are general feeders, and as a rule destructive to sugar beets and other vegetable crops only in seasons which have been particularly favorable to their multiplication, and their operations are mainly confined to fields adjacent to grass lands. The numbers of these insects mount into the hundreds, but the really important species might be reduced to between twenty and thirty. Fourteen are listed as sugar-beet pests.

For present purposes it will be necessary to mention specifically only a few of the most abundant of the grasshoppers. Like most other forms of the order Orthoptera, they are mostly large insects, with mouth parts formed for biting, and with incomplete metamorphoses, the young more or less closely resembling the adults, save for the lack of wings. Their name is sufficient indication of their habits: They live normally on grasses for the most part, and their thighs are large, fitting them for long leaps. Everyone knows them so well that further description is unnecessary. Some species are capable of extended flight for hundreds of miles, with occasional intermissions daily for food. In their migrations they go in swarms, and sometimes darken the face of the sun, or at night of the moon.

Grasshoppers may be classified, as regards their habits, as nonmigratory and migratory. The former breed and pass their entire lives in or near the place where the eggs were laid. The migratory species breed in enormous numbers, and when they become too abundant for the limited food supply of a region, they develop the migrating habit and travel in swarms. These insects are particularly abundant and troublesome in arid and semidesert regions, and as their numbers are subject to great variation according to climatic and other conditions, the visitation of a locust swarm may be expected at any time during the warmer months of the year. In dry regions locusts are the most dreaded of insect pests. Because of their voracity and the rapidity of their attack, they lay waste entire townships, counties, and even large portions of States.

THE RED-LEGGED LOCUST.

(*Melanoplus femur-rubrum* De G.).

This is our commonest North American grasshopper, being found practically everywhere. It is one of the smaller species (fig. 43), and where it is not held in subjection by numerous natural enemies of various kinds it may become a decided nuisance in cultivated lands. It was destructive to sugar beet in Illinois in 1899. It seldom exhibits the migratory tendency, but sometimes gathers in swarms and moves in concert, not, however, rising to great heights, but drifting with the wind as do the true migratory species.

FIG. 43.—*Melanoplus femur-rubrum*—natural size (after Riley).

THE ROCKY MOUNTAIN LOCUST.

(*Melanoplus spretus* Thomas).

This is the most destructive of all native grasshoppers, and has been the cause of greater losses to agriculture in the past thirty years or more than perhaps all of the other known species of grasshoppers combined. Its range of injuriousness is not limited to the Rocky Mountain region, but it is more abundant there than elsewhere. It is illustrated in figures 44 and 45.

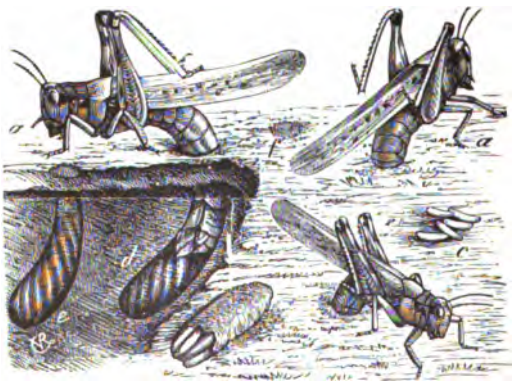


FIG. 44.—*Melanoplus spretus: a, a, a*, female in different positions, ovipositing; *b*, egg-pod extracted from ground, with the end broken open; *c*, a few eggs lying loose on the ground; *d*, *e*, show the earth partially removed, to illustrate an egg-mass already in place and one being placed; *f*, shows where such a mass has been covered up (after Riley).

Those who were interested in farming in the 70's in Kansas, Nebraska, and some neighboring States have cause to remember the depredations of the Rocky Mountain locust. During 1874–1877 it was directly responsible for the loss of $100,000,000, in addition to an indirect loss by the stoppage of business and other enterprises which might have aggregated as much more. It was for an investigation of this species that the

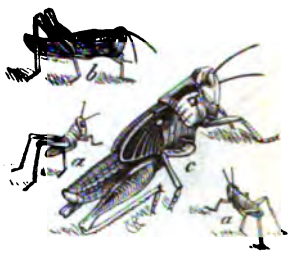


FIG. 45.—*Melanoplus spretus: a, a*, newly hatched nymph; *b*, full-grown nymph; *c*, pupa, natural size (after Riley).

United States Entomological Commission was formed, which published from 1877 to 1879 two voluminous reports on it alone. A shorter account of this and some of the other more important grasshoppers discussed in the Commission Reports is furnished in Bulletin No. 25 (o. s.), Division of Entomology.

THE DIFFERENTIAL LOCUST.

(*Melanoplus differentialis* Thomas.)

In Kansas and Nebraska and elsewhere in the Middle West the farmer is much bothered at times by the large yellow locust, shown in figure 46. It can usually be found along roadsides and on the edges of groves, preferring rank vegetation where such abounds. When it becomes unusually numerous it is quite destructive to vegetable crops and to cereals; in fact, it is rated by some as next in importance to the two species which have been considered. Two forms of this insect make their home in the Middle West—a yellow form, which is the commonest, and a black one. They do not appear to differ otherwise than in color.

FIG. 46.—*Melanoplus differentialis*, natural size (after Riley).

THE TWO-STRIPED LOCUST.

(*Melanoplus bivittatus* Say.)

The name two-striped locust and the accompanying illustration (fig. 47) together with the statement that the ground color of this species is brown, striped with yellow, is sufficient for its determination. It is somewhat variable, however. Like others of its kind it develops where vegetation is rank, in weed patches and in low ground, and after exhausting the vegetation in such localities it enters gardens and cornfields and does much injury to crops. It occurs from the Atlantic to the Pacific, and from the Gulf States to far North.

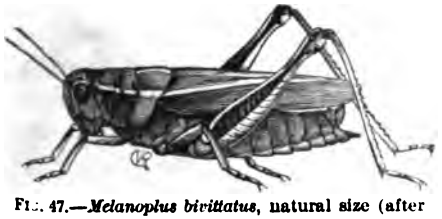


FIG. 47.—*Melanoplus bivittatus*, natural size (after Riley).

METHODS OF CONTROL.

Grasshoppers are generally kept within normal numbers by numerous natural agencies, among which are nearly all large forms of insectivorous birds and mammals, batrachians and reptiles, and fungous diseases. They also have large numbers of predaceous and parasitic

insect enemies, which kill them off in ordinary seasons. With changes of atmospheric conditions, however, the insect and fungous enemies are frequently destroyed, and then the grasshoppers increase in abundance. In such cases they can be destroyed by several artificial methods. The remedies that have proved most efficient are: (1) plowing under the eggs before these have had time to hatch, and

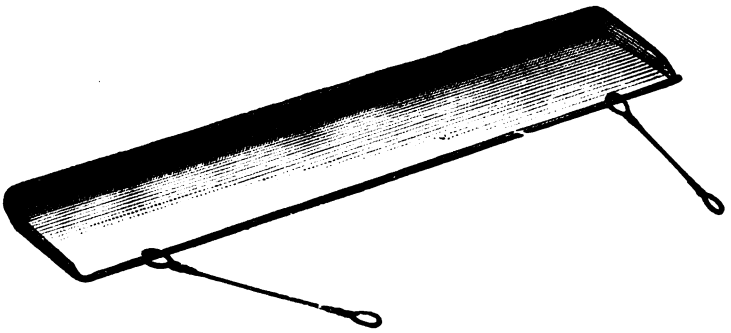


FIG. 48.—A simple coal-tar pan to be drawn by hand (after Riley).

(2) capturing the unfledged locusts, as well as many of those which have become winged, by means of hopperdozers or kerosene pans.

Hopperdozers are necessary implements of warfare against most grasshoppers. They are shallow sheet-iron pans, made of any size most convenient, or canvas frames, mounted on runners to be drawn over the ground either by a horse or by hand, preferably against the wind, in such a manner that the grasshoppers will leap into them and be killed by coming into contact with the tar or oil which is poured into them for the purpose. Two forms of hopperdozers are shown in figures 48 and 49.

FIG. 49.—A canvas hopperdozer to be drawn by horse (after Riley).

Bran-arsenic mixture is another remedy of great value in the prevention of injury to our cultivated crops. The directions for preparing this mash have been given under remedies for cutworms (page 185).

Fungous diseases as a remedy.—During the years 1901–2 the subject of the possible control of grasshoppers by means of contagious diseases was taken up by the Division of Entomology, and a report by Dr.

Howard of progress in experimental work was published in the Yearbook of the Department for 1901 (pp. 459–470). Unfortunately the spread of these diseases is so contingent upon certain weather conditions that while uninfected grasshoppers may be inoculated under the most favorable circumstances, we can not always obtain or predict atmospheric conditions which will operate with the disease in destroying the grasshoppers. The conclusion is therefore reached that, owing to the inability of man to control the conditions necessary to the spreading of the disease, it is far better to employ the bran-arsenic mash, hopperdozers, fall plowing, and other remedies which have been specified where possible in preference to the fungus; in other words, we can not depend absolutely on the fungus, although in some cases it is eminently beneficial, more especially in climates which are unusually moist and in which the conditions desired are ordinarily present. The principal diseases in question are caused by *Mucor ramosus*, *Empusa grylli*, and an undetermined species of the genus Sporotrichum.

Poisoned horse droppings.—During recent years Mr. Norman Criddle has used a mixture with great success against locusts in Manitoba. It consists of 1 part of Paris green mixed thoroughly in 60 parts of fresh horse droppings, 2 pounds of salt to half a barrel of mixture being added after being dissolved in water. This is placed in a half barrel and drawn on a cart to the edge of the infested field or one likely to be invaded. The mixture is then scattered broadcast along the edge of the crop, or wherever needed, by means of a trowel or wooden paddle. The locusts are attracted to it and are killed in large numbers by eating the poison.[a] Although this mixture is "sure death," it sometimes requires from two to five days for it to kill the locusts.

Rye as a trap crop.—Manitoba farmers also deal successfully with locusts by sowing a strip of rye around the edge of a field of wheat. The former grain grows more rapidly and it requires a long time for the insects to eat sufficiently of it to destroy it. The rye is poisoned with a spray of Paris green. Beet fields might be protected in the same manner.

Burning over and plowing.—In some cases it has been possible to ascertain the particular breeding places of grasshoppers, some species depositing their eggs in pasture lands and among foothills at the bases of mountains in the far West in regions in which the tar weed grows. Here the egg cases can be destroyed by burning over the ground late in the fall after all of the eggs are deposited, or by plowing them in to a depth of 6 or 8 inches before they hatch in the spring.

In case, for any reason, it is not feasible to employ any of these last-mentioned remedies, and the place of egg deposit is ascertained, a watch should be kept for the young grasshoppers and they should be

[a] Fletcher, Rept. Ent. and Bot. Experimental Farms, Canada, for 1902, 1903, p. 187.

destroyed as soon as possible after hatching by means of the bran-arsenic mash.

Turkeys.—Prof. Lawrence Bruner, of Nebraska, states that turkeys are useful in freeing orchards and vineyards of grasshoppers and they may be employed in other fields for the same purpose. In one case a flock of 766 turkeys was kept at work in the destruction of grasshoppers. The turkeys have to be watched, however, as they sometimes vary their diet with vegetables.

Cooperation is of the greatest value in the treatment of grasshoppers, particularly in regions where they reach their greatest development; and the thoroughness with which work is done in one year will show in the greatly reduced numbers with which the farmers will have to deal the next season.

Many of the remedies that have been advised as remedies for grasshoppers in general are applicable to the migratory forms, but these frequently occur in such immense swarms that it is practically impossible to check them until the crops are destroyed. It is of the highest importance, therefore, that remedies be employed at the very first onset, and that these measures be generally observed over considerable territory, as the insects fly rapidly from one field to another.

LEAF-MINERS.

Three forms of maggots, the young of small two-winged flies, more or less resembling the common house fly, mine the leaves of beets and spinach, causing variable blotches on the outer cuticle, which is left entire until ruptured by the escape of the maggot when it matures and deserts its old home for transformation in the earth below. The abandoned mines dry, shrivel, and become torn by subsequent growth of the plant.

THE BEET OR SPINACH LEAF-MINER.

(*Pegomya vicina* Lintn.).[a]

The beet or spinach leaf-miner is the best known of these insects, and at the present time the only one that need be considered. It is practically confined to beets, spinach, and like plants, such as lambs-quarters, and is to be reckoned among prominent beet pests, as it is apparently increasing in destructiveness.

The parent fly is shown at figure 50, *a*, *b* representing the head of the male, and *c* that of the female. The ground color is gray with the front of the head silver white. The body, including the legs, is rather

[a] Lintner, 1st Annual Rept. Insects N. Y. for 1881 (1882), pp. 203–211; Howard, Insect Life, Vol. VII, pp. 379–381; Sirrine, 14th Rept. N. Y. Agricultural Experiment Station for 1895 (1896), pp. 625–633; Pettit, Bul. 175, Mich. State Agr. College Exp. ta., 1899, pp. 356–357.

sparsely covered with long stiff black hairs. When in action the body is carried usually in a somewhat curved position, but when extended measures nearly a quarter of an inch. The maggot (*f*) is white, and so nearly transparent that the contents of the abdomen can be seen through the posterior portion.

In many cases infestation can be traced directly to the insects having bred in lambs-quarters and similar weeds, which if not destroyed by ordinary methods of cultivation mature and die during October. The flies, by close observation, may be seen in flight just above the ground or hovering about their different food plants. The eggs are placed on the lower surface of the leaves and arranged in masses of from two to five. When the young hatch they bury themselves

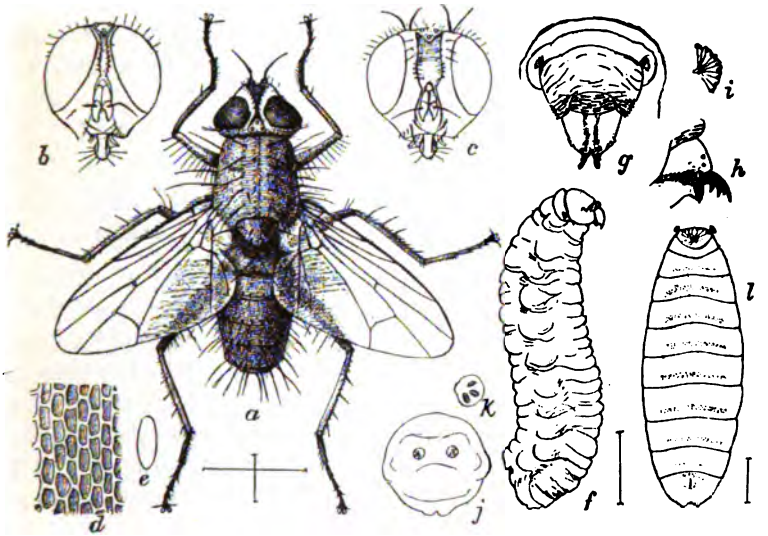


FIG. 50.—*Pegomya vicina: a*, fly; *b*, head of male fly; *c*, head of female; *d*, surface of egg, highly magnified; *e*, egg; *f*, maggot; *g*, head of same; *h*, cephalic hooks of maggot; *i*, prothoracic spiracles; *j*, anal segment; *k*, anal spiracles; *l*, puparium—all enlarged (after Howard, Division of Entomology).

within the leaf tissue, constructing a thread-like mine which they afterwards extend in a curve or semicircle.

Transformation to pupæ takes place in most cases in loose soil, which the maggots enter only to a short distance or under fallen leaves. Occasionally maggots transform within a leaf if the latter happens to rest on the ground.

Injury appears to be most frequent in late fall, but may be due to earlier generations in midsummer. Dr. Howard states that eggs hatch in from three to four days, and the larval stage is passed in seven or eight days, the puparium or resting stage requiring from ten to twenty days. These periods will vary according to the state of the atmosphere. An instance of damage to spinach in Pennsylvania was reported in May, 1903.

Methods of control.—When this leaf-miner occurs in kitchen gardens it is most easily controlled by gathering and destroying the leaves as soon as found infested, and neighboring plants which serve it for food should be treated in the same manner. In large fields of sugar beet much injury might be averted by proceeding in the same manner at the outset of attack.

Insecticides have been suggested, but the habit of the maggot of feeding within the leaf at once indicates their uselessness. Kerosene emulsion has been tried without effect. Mr. Sirrine has observed that many gardeners and farmers on Long Island, where this insect is a spinach pest of importance, have practiced late fall and early spring plowing, and are still troubled with it. But it is probable that clean culture is not also practiced, hence the insects have an opportunity to breed in weeds and return to cultivated plants. As the insect appears to prefer spinach to beets, it is possible that the former might be used as a trap crop in sugar-beet fields.

PLANT-BUGS.

The sugar beet furnishes sustenance for hordes of sucking insects, such as plant-bugs, plant-lice, leaf-hoppers, root-lice, and numerous related forms, but many of these insects live normally on wild plants, weeds, and grasses, on which their younger stages are passed, and prefer most other vegetable crops, when readily obtainable, to beets. Among the more common forms of these insects which obtain nourishment by suction are several species of true bugs of the family Capsidæ, generally termed plant-bugs, although some forms are also known as leaf-bugs, chinch bugs, and by similar names indicative of their habits or appearance. The commonest and most injurious of these insects are two forms of false chinch bugs and the tarnished plant-bug and garden flea-hopper.

THE TARNISHED PLANT-BUG.

(*Lygus pratensis* Linn.)

As this is the commonest of all bugs, and, according to general verdict, one of the most troublesome, it may serve as an example of this class. It is at home practically everywhere in North America, from Canada to Mexico, and attacks most plants whether cultivated or wild. It occurs in fields of sugar beet throughout the warm season, and frequently does damage to garden crops, both vegetable and fruit, and to trees grown in nurseries.

The mature plant-bug is of the appearance shown in figure 51 at the left. The general color is a pale, obscure, grayish brown, marked with black and yellow, the thorax also with red. The pattern is variable, but more or less as illustrated. The legs are still paler brown or yellow-

ish, ringed with darker brown. The length is about one-fifth or three-sixteenths of an inch.

This plant-bug has been stated to pass through four stages of growth from the time it hatches from the egg until it reaches the adult condition, but there is little doubt that there are five stages, to agree with other species of plant-bugs which have been traced through their metamorphoses. In the first stage the insect measures only one-twentieth of an inch, and is yellowish or yellowish green in color. The known stages are shown in figures 51 and 52.

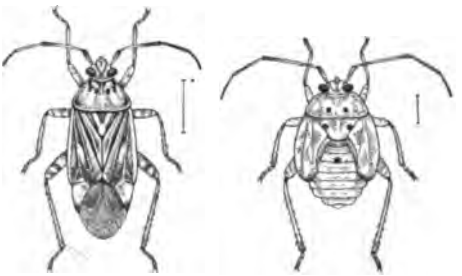


FIG. 51.—*Lygus pratensis:* adult bug at left; last stage of nymph at right—nearly four times natural size (original, Division of Entomology).

Were it not for the fact that this plant-bug feeds upon such a variety of crops as well as weeds, thus diminishing the damage, it would be much more injurious than it really is. It has been asserted, and with probable truth, that the puncture of the bugs is poisonous to plant life.

The bugs are extremely active, and quick of flight as well as on foot, and when disturbed in the least have the habit, in common with many other plant-bugs, of dodging to opposite sides of the plant, where they remain out of sight.

The tarnished plant-bug, as previously stated, can be found afield throughout the season, appearing in early spring and disappearing only when cold weather approaches. Hibernation is usually in the adult stage, but the nymphs or immature forms are sometimes seen under circumstances that would lead to the belief that the species also winters over in this stage. The insects pass the winter under any convenient shelter, particularly in rubbish left in fields and in fence corners, and under leaves, boards, and stones. After copulation in early spring the females deposit their eggs singly and directly on their host plants, oviposition continuing for two weeks or longer.

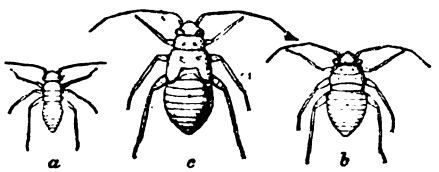


FIG. 52.—*Lygus pratensis: a*, newly hatched nymph; *b*, nymph of a later stage; *c*, fourth stage—three or four times natural size (after Forbes, Division of Entomology).

Remedies.—The great activity of the tarnished plant-bug, coupled with its habit of feeding on so great a variety of plants, passing from one to another with no apparent choice, renders it more difficult of control than if it were concentrated. It can not be kept in bounds by any single remedy, at least when it occurs in great numbers. In the application of insecticides, or other remedial measures, it is necessary

to include other food plants or most forms of vegetation in order to keep the insects away from the crop which is being injured.

Kerosene emulsion is one of the best remedies, but must be applied thoroughly and at frequent intervals.

Pyrethrum must be applied in the same manner, but as it is one of the most expensive of insecticides its use would hardly be profitable on beets, although valuable on some other plants subject to injury, for example, on berries, where it is impossible to apply poisons that would be harmful to man.

If insecticides are employed they are best applied early in the morning, before the insects have become thoroughly active and while the dew is on the plants, as this facilitates the spreading of most applications which are used.

Hand methods, although scarcely applicable to large fields, are of the greatest value over small areas, and a hand net of stout cloth is useful for sweeping plants and surrounding grasses and weedy vegetation in which the insect is sure to be found. A day's experience will be sufficient to teach anyone that more insects can be captured in this manner than in any other.

Clean culture, although mentioned last, is the first necessity, and if fields subject to injury by this plant-bug are kept free from weeds of all kinds and the rubbish is cleaned away as soon as the crop is harvested, losses will be greatly lessened. After a crop is off "burning over" or "back firing" should be practiced in the same manner as already described in connection with army worms and cutworms.

THE FALSE CHINCH BUG.

(*Nysius angustatus* Uhl.)

This plant-bug is a beet feeder of long standing, and like many other species which have been mentioned, shows a tendency toward being omnivorous, although cruciferous plants, such as cabbage and turnip, appear to be the favorite food. It does more or less injury to potato, lettuce, grapevine, strawberry, and even grass and the foliage of apple trees. Its English cognomen is derived from the fact that since very early times it has been sent by correspondents to official entomologists under the impression that it was the true chinch bug, to which, indeed, it is related.

It is grayish brown and of the appearance shown at figure 53, *c*, measuring about one-eighth of an inch. In the same figure, at *a*, a leaf of potato is illustrated, which shows minute circular specks which are rusty in color where the beak of the bug has been inserted. This recalls the method of attack of certain flea-beetles which have already been described. When occurring in large numbers the false chinch bugs crowd together on plants after the manner of chinch bugs on corn,

and harlequin bugs on cabbage, and as they feed by suction they soon exhaust a plant by depriving it of its vital juices, causing it in time to wilt and perish. The distribution of the species extends from New Hampshire to the Gulf, and westward to the Pacific States. It is subject to the same atmospheric influences as the true chinch bug, damp, rainy weather being unfavorable to its development.

Remedies.—The best manner of holding this bug in control consists in clean culture, keeping down all purslane, a favorite host plant, the careful cleaning up of crop remnants and other trash before winter, and the collection of the bugs when they occur in numbers in pans or pails filled with water and a thin scum of kerosene. The free use of kerosene emulsion and pyrethrum is also of value, the latter, though expensive, being efficient in small fields.

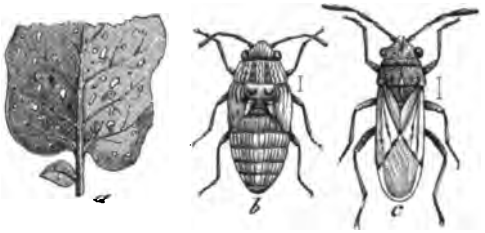


FIG. 53.—*Nysius angustatus:* *a*, part of small leaf of potato, showing punctures of the bug; *b*, last stage of nymph; *c*, adult—*a*, natural size; *b*, *c*, much enlarged (after Riley, Division of Entomology).

THE MINUTE FALSE CHINCH BUG.

(*Nysius minutus* Uhl.)

According to recent reports emanating from several sources in Colorado, this insect is of growing importance as a beet pest. It appears to be more particularly destructive to beets grown for seed, the injury being accomplished by the bugs sapping the green seed, which in consequence dries up and fails to mature properly.

It differs but slightly from the previously mentioned species, being a little smaller, measuring only about a sixteenth of an inch in length. Its distribution and its food habits appear to be practically the same, in fact additional study is necessary to determine whether the two forms are actually distinct species.

Remedies.—It has been ascertained by beet growers that the flooding of infested fields causes the insects to leave, and the growing of mustard as a trap crop has given excellent results, precautions being taken that the mustard be not allowed to run to seed, as it is likely to become a pest itself. Other remedies advised for the common false chinch bug just considered are also applicable.

THE GARDEN FLEA-HOPPER.

(*Halticus uhleri* Giard.)

In recent years this minute black bug has been the occasion of considerable injury in various parts of the country. In 1890 it did damage to beans in Kansas, and in 1896 like injury was inflicted on red clover and other plants in Ohio. It is commonly seen in beet fields,

but evinces a partiality for leguminous plants, including cowpea and pea, and has also been destructive to smilax in greenhouses and to potato, morning-glory, and chrysanthemum. In 1897 it was somewhat troublesome on edible legumes in Maryland. Among other plants which it attacks are egg-plant, pumpkin, cabbage, and numerous weeds. It occurs most abundantly on the under side of leaves, which it punctures so as to cause the death of the tissue in small, irregular, somewhat characteristic white patches.

This species is shown highly magnified in fig. 54 in the three forms of its adult stage. In its brachypterous or short-winged form it greatly resembles the common black cucumber flea-beetle, alike in appearance, in the nature of its work, and in its saltatory power. It is evidently native and well distributed from Canada and New England southward to Florida and westward to Utah. This shows a range

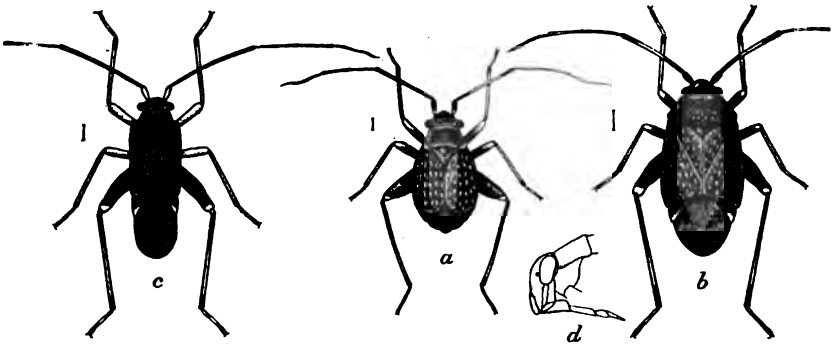


FIG. 54.—*Halticus uhleri:* *a*, brachypterous female; *b*, full-winged female; *c*, male; *d*, head of male in outline—*a*, *b*, *c*, much enlarged; *d*, more enlarged (author's illustration, Division of Entomology).

from the Boreal life zone to the Gulf strip of the Lower Austral. According to the observations of Mr. F. M. Webster, this species may hibernate in the adult stage, although probably it usually passes the winter in the egg.

Remedies.—The best remedy is kerosene emulsion applied thoroughly as an underspray.

Many of the instances of injury that have been reported have been largely due to the planting of susceptible crops in the immediate vicinity of clover, which is evidently the preferred host plant. When the clover is cut the flea-hoppers migrate to other crops, and when sufficiently numerous cause damage. It is obvious that with a little care in cropping, such as the avoidance of growing crops subject to injury in the immediate vicinity of clover, much injury would be averted.

LEAF-HOPPERS.

Numerous species of leaf-hoppers, insects which obtain their food by suction in the same manner as plant-lice, are nearly always to be found on sugar beet and similar vegetables. None of these, however, appears to be restricted to vegetables for food, but usually develop on grasses, although occasionally also on other plants. As a rule, in their earlier stages they exhibit a decided limitation to the food plant on which they began breeding; but as they near the more mature stages they assume the habit of feeding more indiscriminately. Considerable divergence is exhibited in regard to life histories; but since these insects are, as a rule, not particularly destructive to beets, further discussion of this general problem may be omitted.

THE CURRANT LEAF-HOPPER.

(*Empoasca mali* Le B.)

This leaf-hopper is described by Messrs. Forbes and Hart as "probably our worst all-round leaf-hopper pest, so excessively abundant that notwithstanding its varied diet it is able to make a serious attack on quite a number of the cultivated plants on its list." It has been found in extreme abundance on sugar beet everywhere in Illinois, both as nymph and adult, showing its ability to breed on this plant. It also attacks beans, cowpea, potato, celery, and corn, and various fruits, as well as shade and forest trees. It is a tiny insect, pale green in all stages, and is apt to be confused with related species. The row of six (sometimes eight) white dots along the anterior margin of the prothorax distinguishes it from others.

THE FLAVESCENT LEAF-HOPPER.

(*Empoasca flavescens* Fav.)

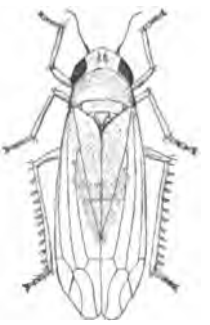


FIG. 55.—*Empoasca flavescens*—highly magnified (original, Division of Entomology).

Very similar to the preceding in appearance, size, habits, and distribution is the above-mentioned species (fig. 55). It is sometimes even more abundant. It is paler, nearly white, and has only three spots on the margin of the thorax.

REMEDIES.

As a result of studies of the life economy of leaf-hoppers, it has been ascertained that simply cutting the grass and perhaps some other plants affected, and leaving it in the field, will prevent eggs from hatching; the drying of the stems results in the crushing and distortion of the eggs, owing to the shrinkage of the plant tissues and the curling of the edges of the sheaths.

PLANT-LICE.

Several forms of plant-lice affect the leaves of sugar beet, but as far as at present known do not inflict extensive injury. Among the plant-lice, however, are some few forms which have the habit of feeding on the roots, being known as root-lice, and these are of the greatest importance when atmospheric conditions conduce to their development or the plants are first injured through other causes.

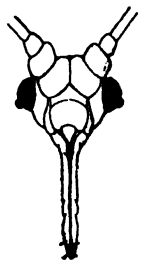


FIG. 56.—Head of plant-louse, showing sucking beak—much enlarged (original, Division of Entomology).

THE MELON PLANT-LOUSE.

(*Aphis gossypii* Glov.)

The melon plant-louse or, as it is more commonly known, the melon louse, is perhaps the commonest species found on beets, and is the best known as well as most destructive of all insects of this class. Fortunately for the beet grower it does not favor this crop, and is usually found only in moderate numbers on beets when other plants are available. The writer has seen a considerable number of this species on beet leaves working in their usual manner by pumping up the juices through their beaks (fig. 56), but although the plants were carefully watched the operations of the plant-lice did not seem to hinder the growth of the plants in any degree. Nevertheless, this louse is capable of serious damage, more especially in the event of exhaustion of favorite host plants, like melons and other cucurbits, which would drive it to beets if these were most available. The principal forms of this insect are illustrated in figure 57.

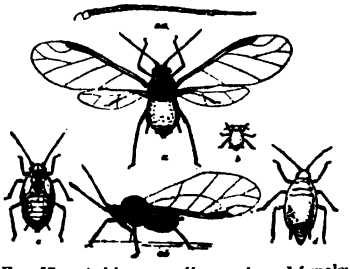


FIG. 57.—*Aphis gossypii*: *a*, winged female; *aa*, enlarged antenna of same; *ab*, dark female, side view; *b*, young nymph or larva; *c*, last stage of nymph; *d*, wingless female—all greatly enlarged (original, Division of Entomology).

The melon louse is probably of American origin and perhaps tropical, since it prefers plants of a tropical nature, has a very wide distribution in North and South America and the West Indies, and has been observed in Australia. It is therefore apt to be present in most fields of sugar beet, but its occurrence there can usually be traced to other plants on which it develops more freely, some of which have already been mentioned. Among others of the favorite host plants are cotton, okra, purslane, strawberry, and orange and other citrus trees. Attack begins in early spring and may last until winter, according to season, climate, and other circumstances.

Natural enemies.—As an illustration of an insect pest held in abey-

ance and limited to innoxious numbers by natural enemies, no better example could be cited than is afforded by this plant-louse. Its natural enemies include several species of ladybirds or "ladybugs," syrphus flies, aphis lions, the larvæ of lace-wing flies, numerous species of minute hymenopterous parasites, and a parasitic fungus. The insect enemies are most effective in destroying the plant-lice in dry and warm weather. In a cool, damp atmosphere, which is apt to be encountered early in the season when plants are first set out, the insect enemies are as a rule less active, and at such times injury by plant-lice is likely to be most severe.

The species shown in figure 58, known as the convergent ladybird (*Hippodamia convergens*), is one of the most beneficial insects, as it is

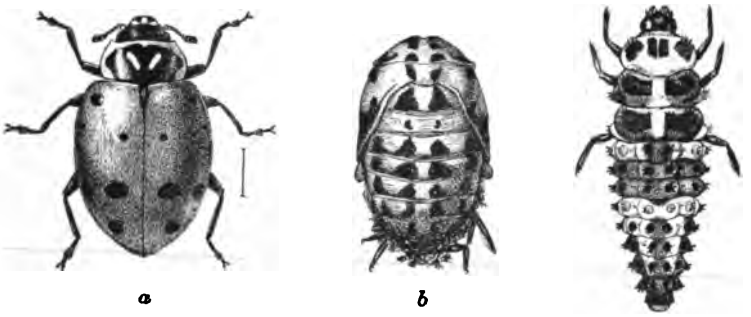


FIG. 58.—*Hippodamia convergens*: *a*, adult; *b*, pupa; *c*, larva—all much enlarged (original, Division of Entomology).

a most active destroyer of plant-lice which feed on vegetables. It is common on sugar beets, and it is interesting to note that on one occasion it was reported as feeding on the leaves of that plant in Oregon (Bul. 26, o. s., Div. Ent., p. 11).

METHODS OF CONTROL.

The melon louse, although a difficult insect to treat when it occurs on cucurbits and some other plants, can be more readily controlled on beets. In fact, all of the leaf-infesting plant-lice can be destroyed on beets by means of sprays and other washes and by some of the ordinary general methods of farm practice.

Kerosene emulsion.—The standard remedy for plant-lice is kerosene-soap emulsion, made by combining 2 gallons of kerosene, half a pound of whale-oil or fish-oil soap or 1 quart of soft soap, with 1 gallon of water.

In preparing this emulsion the soap is first dissolved in boiling water and then poured while boiling hot, but away from the fire, into the kerosene. The mixture is then churned somewhat violently for about five minutes by means of a force pump and direct discharge

nozzle throwing a strong stream by pumping the liquid back upon itself. When properly combined the mixture will have become of the consistency of thick cream. It is then placed in moderately tight receptacles, and will keep almost indefinitely until required for spraying, when it is to be diluted. For plant-lice this staple emulsion is usually diluted with from 10 to 15 or 20 parts of water.

Its habit of feeding on the lower surfaces of leaves renders the melon louse more difficult to reach by means of a spray than insects which live on the upper surfaces. In the application of an emulsion or other wash, therefore, it is necessary that the hose be fitted with an upturned nozzle in order to secure the under spraying of the leaves, which is the principal resort of plant-lice and many other sucking insects.

It is of the utmost importance that the sprays or other remedies be applied on the first appearance of the insect in order to check it before it succeeds in obtaining a good start and to prevent its further development.

Spraying with water.—A strong stream of water from a hose directed on plants, so as to hit the insects, is of much value in dislodging them from the plants, to which they do not usually succeed in returning, and where this can be readily done more elaborate remedies are unnecessary.

Pyrethrum administered with a powder bellows to the lower sides of leaves is also valuable and particularly effective on young plants. It is, however, expensive, and can not be profitably used in large fields.

Clean culture and fall plowing should be followed as the most effective measure of prevention of attack by plant-lice as well as other insects, and this includes the keeping down of weeds after the main crop has been gathered until the next crop is planted, this treatment serving to rid the fields of many pests, particularly those which do not fly readily, by depriving them of food.

Fumigation methods.—In very recent years two methods of fumigation have been rather extensively practiced as a means of destroying the melon louse and related insects on valuable plants. It is doubtful, however, if either of these remedies would be necessary on beets except in regions where injury is more extensive than has thus far been reported.

If careful watch is kept for the first appearance of this plant louse it can be more thoroughly eradicated by means of fumigation than by any other method. The method of application of bisulphid of carbon consists in covering the affected plants on the first appearance of the pest with a tub or similar receptacle, and evaporating the chemical beneath this at the rate of a dram to 1 cubic foot or less of space

inclosed. A tablespoonful serves for ordinary tubs. This treatment does not injure the plant, and if the tub fits tightly to the ground the vapor of the bisulphid is retained and the lice will all be killed. This remedy is much used by growers of melons and cucumbers who watch their vines carefully, removing and destroying affected plants and fumigating those which can be saved.

THE BEET APHIS.

(*Pemphigus betæ* Doane.)

This insect is a root-louse and comparatively new as a pest. Attention was first drawn to it in 1896, and for three or four years afterwards it did considerable injury to sugar beet in Washington.[a] We do not know its full life history nor its distribution, but it occurs also in Oregon and probably in California. In Oregon a thousand tons or more of beets were ruined in a year in a single valley. This insect is one of many which may be seemingly harmless up to a certain point, but, with a changed environment, become of more importance economically.

The smaller rootlets of beets are first attacked and, when the aphis occurs in large numbers, they are soon destroyed. The loss of these so weakens the plant that it is not able to withstand further attack, and, as a result, the leaves wither and the beet shrivels and becomes spongy. Wild yarrow (*Achillea lanulosa*) appears to be a normal host plant, and when its roots are examined in localities where the insect abounds, they will frequently be found covered with the white woolly excretion of the insect, while the louse itself is feeding on the smaller rootlets. This species also lives on knotweed or door-mat weed (*Polygonum aviculare*), on grasses, and some other plants. It is likely to increase its range, but this may be a matter of slow accomplishment, unless it is introduced from one locality to another on beets in shipment.

METHODS OF CONTROL.

Owing to the large acreage which is planted in sugar beet in many portions of our country, it does not seem probable that we can treat satisfactorily an insect like this root-louse, which feeds underground, by means of insecticides. Kerosene emulsion and bisulphid of carbon will no doubt kill it, but the expense would be excessive were either used on a large scale. Nor can we hope entirely to eradicate the pest when it has taken up quarters in our fields by means of cultural methods. Additional observations on its life history and experiments look-

[a] Cordes: Sugar Beet Gazette for November, 1899; Doane: Bul. 42, Wash. State Agr. Expt. Sta., 1900, pp. 3–11.

ing to better methods for its destruction are necessary. It has been reported of the beet-root louse, which will receive next treatment, that in spite of heavy flooding and plowing in winter, the exposure of infested soil to frost, the number of the insects the following year was much larger. Nevertheless, in some localities these farming methods might be employed with better success against one or the other of these two insects. The best that can be recommended at the present time is to avoid planting beets on land where other food plants of this root-louse grow and where it is known to be established, and to practice judicious rotation of crops. It is advisable also to search for these food plants and destroy such as are of no value. Where the insects are found here and there in fields it might be found profitable to kill them by means of kerosene emulsion applied to the roots so as to soak down into the ground, making use of this remedy before rainfall or following it where possible with a copious flooding of water.

Possibly in time some of our insect friends, such as certain forms of ladybirds, syrphus flies, or parasitic insects, may come to the rescue and solve the problem. Ants are without doubt associated with this as with other root-lice and serve as distributors of infestation by carrying wingless lice from plant to plant. If ants occur in the same fields and it can be seen that they foster the root-lice, their nests should be sought out and destroyed.

THE BEET ROOT-LOUSE.

(*Tychea brevicornis* Hart.)

The above name is suggested for a subterranean plant-louse described in 1894 (18th Rept. Ins. Ill. for 1891–92, p. 97), and found about corn roots in Illinois. Considerable complaint has been made of injury to sugar beets in Colorado in 1901 and 1902 by what is now considered this species. It was described as sapping great numbers of beet roots, diminishing the stand to a large extent. The winged insect was noticed as early as April 1st. A correspondent of the division of entomology, Mr. W. K. Winterhalter, stated that many fields in the Arkansas Valley were infested, and expressed the opinion that if the pest should continue to spread, the sugar-beet industry might be seriously damaged. It is quite apparent that this insect is increasing as a pest, and that it will be difficult to control, as it has already shown its capability of development on a variety of plants, including wild grasses and cereals, among which are corn and sorghum, and such weeds as pigweed, lambs-quarters, "salt-grass," and purslane.

Remedies.—The remedies to employ are the same as for the preceding species of root-louse.

WHITE GRUBS AND MAY BEETLES.

Several species of white grubs and wireworms, the young of May or June beetles and of "snap bugs" or "skipjacks," respectively, attack the roots of beets, but none of them appear especially to favor this form of food and we have yet to learn of very serious damage by any of them. Both of these forms of insects follow the planting of beets in grass lands, and if some other plant be used as a first crop before the planting of beets in virgin prairie or in sod land the chances of infestation will be reduced to a minimum.

It is recorded that about 15 per cent of a field of beets was once destroyed in Nebraska by white grubs, and the roots of beets in central Illinois have also been injured, causing the plants to wilt. Only two forms of white grubs have been identified with attack on beets, but there are undoubtedly many more which affect this crop.

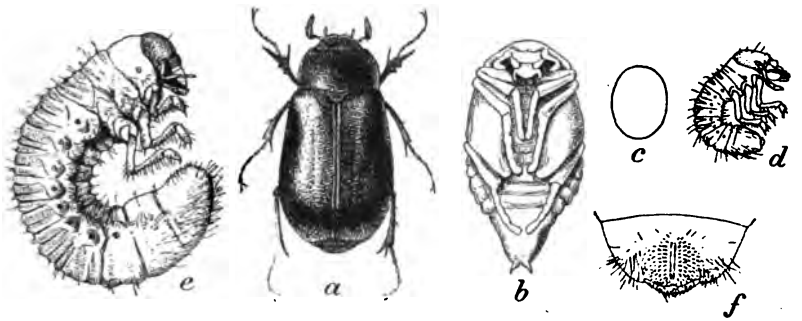


FIG. 59.—*Lachnosterna arcuata:* *a*, beetle; *b*, pupa; *c*, egg; *d*, newly hatched larva; *e*, mature larva; *f*, anal segment of same from below—*a*, *b*, *c*, enlarged one-fourth; *c*, *d*, *f*, more enlarged (author's illustration, Division of Entomology).

One of the commonest forms of May beetles is illustrated, with its white grub, in figure 59, which also shows the egg and pupa. A more complete account of this species is furnished in Bulletin 19, new series, of the Division of Entomology (pp. 74–80).

THE RUGOSE MAY BEETLE.

(*Lachnosterna rugosa* Mels.)

This species was found by Forbes and Hart in the year 1900 injuring the roots of beets in central Illinois and causing the plants to wilt. The beetle is of about the same size and color as the arcuate May beetle previously mentioned. It is a little paler, however, and the elytra are more distinctly lined with ridges, while the thorax is more strongly and much more closely covered with punctures. Its distribution extends from Massachusetts to Louisiana and Texas, and westward to Colorado and Montana.

METHODS OF CONTROL.

Living as white grubs do, underground, and often at a very considerable depth below the surface, it is obvious that it is a matter of extreme difficulty to reach them with insecticides. Gas lime has been suggested for this purpose, and good results have followed the experimental use of bisulphid of carbon and kerosene emulsion against allied species.

Kerosene emulsion is an effective remedy where small areas, such as beds of strawberries grown for home consumption, are affected. It should be diluted about ten times, and poured over the surface of the ground about the infested plants. It is well to make the application just before rainfall, that it may be washed deep into the soil, so as to come into direct contact with the larvæ. If rain does not fall within a day or two after its application a copious watering should follow.

It is to be regretted that both the bisulphid of carbon and kerosene emulsion remedies are too expensive for use on a large scale, but white grubs may be effectually killed off on lawns and in small fields and gardens by the use of the latter.

Fall plowing.—Everything considered, the most useful remedy is found in fall plowing. The land should be thoroughly broken, so as to leave it loose, and the grubs and their parents, the May and June beetles as well, exposed as much as possible to the elements during the winter. This is particularly valuable in cold weather, as the white grubs are not able to withstand exposure to a severe frost. A cross plowing is sometimes advisable where there is severe infestation. This will insure the ground being often disturbed, and if it is kept clean of weeds and other vegetation the grubs will be held in nearly complete control though not exterminated. Summer fallowing of infested land is said to be useful.

Rotation of crops is also valuable in connection with fall plowing. In case infested meadow land is desired for the planting of beets, corn, strawberries, or other crop subject to severe injuries by white grubs, an application of fertilizer, such as nitrate of soda or kainit, put on as a heavy top dressing after the ground is prepared and before planting, has proved of benefit in some cases.

Domestic animals.—Chickens and turkeys, as well as several species of insectivorous birds, are efficient destroyers of white grubs, and much good may be accomplished by encouraging domestic fowls to follow in the furrows to pick up the grubs as they are turned up by the plow. Hogs, as is well known, are also exceedingly fond of white grubs, and if allowed the run of localities where these are abundant, after the crop is made, they will root up the ground and devour great numbers of them. These and many wild animals also kill and devour the beetles when they have opportunity.

Care in the selection of manure.—As manures are frequently infested by white grubs, some of which are at times troublesome, it is well to exclude such forms as experience has shown to contain an excess of these creatures, as, for example, horse manure. The white grubs can be identified readily by disintegrating the material, and chickens and other fowls can be utilized in destroying them before the manure is spread on the fields.

Attracting to lights.—May beetles are strongly attracted to lights, and especially to electric-light globes. They can be captured to some extent by means of stationary lanterns and pans of water, on which is floating a thin scum of kerosene, placed below the lanterns. The traps should be stationed at intervals about an infested field, particularly around its borders.[a]

THE CARROT BEETLE.

(*Ligyrus gibbosus* DeG.)

This beetle was reported during the year 1890 by Professor Bruner as having been quite destructive to the sugar beet in the western portion of Nebraska. They worked for the most part on old ground where irrigation was practiced, and their operations extended on the roots from the surface of the ground to 3 or 4 inches below; in some instances 7 inches.[b] This insect is better known as a carrot pest, and is, in fact, one of the worst known enemies of carrot, parsnip, and some related plants. Injury is due to both larvæ and beetles. Young corn is often cut just above the roots, and the root crops mentioned are punctured with little holes, rendering them unfit for market. Tubers of potato and sweet potato are also subject to attack, as are the roots of celery. Other plants affected include the roots and tubers of sunflower and dahlias as well as cotton.

FIG. 60.—*Ligyrus gibbosus:* adult—enlarged (original, Division of Entomology).

The beetle closely resembles the May beetle, but it will be noticed by reference to figure 60 that the surface of the wing-covers is strongly sculptured and coarsely punctate. The beetle measures about a half to five-eighths of an inch in length, with considerably shorter legs than in the true May beetles. The dorsal surface is similarly colored,

[a] NOTE.—It is often desirable to protect choice trees against the ravages of the beetles. For this purpose nothing is better than mosquito netting. Beetles may be beaten from the trees into inverted umbrellas or similar receptacles, and can be readily captured and killed, as they make little effort to escape after being dislodged. Spraying with arsenicals is of no practical use, as the beetles continue feeding until the poison takes effect, and the next day the dead are replaced by other individuals.

[b] For particulars see Bul. 23, o. s., Div. Ent., p. 17.

but the lower surface is reddish brown and the legs are clothed with reddish-yellow hairs.[a]

Remedies.—Unfortunately the carrot beetle works under ground, like common white grubs, and for that reason is as difficult to control. Injury is largely confined to the beetles, although the larvæ do some injury. If we could ascertain the principal breeding places, this might furnish a solution of the problem. The grubs may be treated as described in preceding paragraphs. In a case of reported injury to the roots of sweet corn in Minnesota in 1902 the presence of the carrot beetles was traced to their having developed in horse manure on the infested grounds;[b] hence avoiding the use of this as a fertilizer or the destruction of the white grubs in the manure is recommended. Crop rotation is one of the best remedies, and it is probable that trap lights might yield good results, as these insects are more attracted to bright lights than are ordinary May beetles, although it is not known to what extent the beetles might be lured from the fields after they have begun to feed.

WIREWORMS.

The sugar beet, as has been said, is so nearly exempt from injury by wireworms that this plant, as also spinach, might be profitably used as an alternate in the cultivation of corn, various other cereals, and vegetable crops, such as potatoes, which are frequently very badly infested by these insects. Occasionally wireworms of several species have been found eating into the smaller roots of beets and burrowing into the tap roots and crowns, causing the plants attacked to shrivel and die. Messrs. Forbes and Hart have indicated two species of wireworms as having been concerned in such injury, *Melanotus cribulosus* and *Drasterius elegans*, both of which have been observed about beet roots which had been more or less injured and eaten away.

The term wireworm is applied to numerous forms of elongate wire-like creatures, the larvæ of snapping beetles or "snap-bugs," of the family Elateridæ. Many species are injurious to cultivated crops and are often very troublesome in cornfields. A large proportion of the wireworms are shining yellow in color, while many of the adults, like the species figured, are brown and covered with close brown or yellowish pubescence.

The life history of injurious subterranean species is in some respects similar to that of white grubs, the beetles being among the earliest spring arrivals, occurring in April and May, and flying rapidly in the heat of the day.

The eggs are generally deposited in moist places grown up with grassy vegetation, weeds, or corn, and the larvæ upon hatching feed,

[a] A more complete account is given on pp. 32–37 of Bul. 33, n. s., Div. Ent.

[b] Washburn, 7th Rept. Ent. Minn. for 1902, pp. 47–49.

like the white grubs, upon the roots, developing slowly and requiring about the same period for the perfection of the life cycle—about two or three years. Like the white grubs, also, the wireworms transform to pupæ in autumn, and the change to the beetle form takes place before winter, the beetles usually remaining in a quiescent state until their emergence the following spring.

Two common and injurious species are chosen as examples of this class, although it must be remembered that they have not been determined as beet feeders. The first is known as the wheat wireworm (*Agriotes mancus* Say), and is shown four times natural size in figure 61. The other is called *Monocrepidius vespertinus* and is introduced here because known in its three principal stages (fig 62).

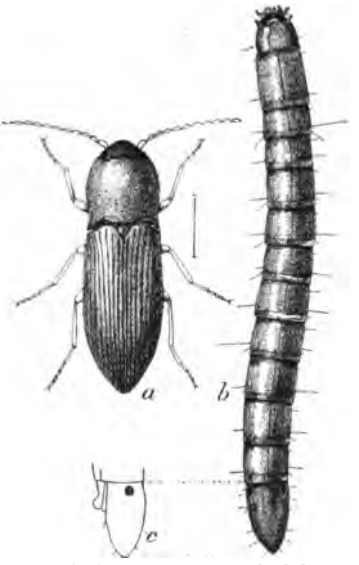


FIG. 61.—*Agriotes mancus: a*, beetle; *b*, larva; *c*, anal segment of larva in profile—about four times natural size (author's illustration, Division of Entomology).

Remedies.—Owing to their extremely hardy character, indicated by the hard, firm texture which has given them the name of wireworms, as well as to their subterranean nature, these insects are even more difficult to treat satisfactorily than the white grubs.

Of direct applications, poisons are of little value, but salt in large quantity has been used by some persons with success for many years, and has been reported to be one of the most effective applications that can be made. Strong brine, however, must be used with caution, as it sometimes destroys certain forms of plant life. Different forms of salty fertilizers are also said to be of value, both as stimulants to the affected plants and as insecticides. Among these are kainit and nitrate of soda.

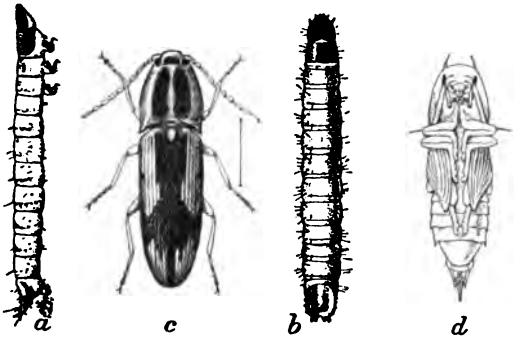


FIG. 62.—*Monocrepidius vespertinus: a*, larva, side view; *b*, same, dorsal view; *c*, beetle; *d*, pupa—about three and one-half times natural size (author's illustration, Division of Entomology).

Clean cultivation and poisoned baits are also recommended, the same as for white grubs. In fact, where remedial measures are in use against either cutworms or white grubs, they apply also to wireworms, but are less effective.

One of the best forms of bait to be used consists of slices of potatoes or other vegetables poisoned in the same manner as advised in the consideration of cutworms.

MISCELLANEOUS ROOT-INFESTING INSECTS.

In addition to white grubs, wireworms, and root-lice, which have been treated as invading the underground portion of beets, a few other species are found at the roots. Prominent among such are the seed-corn maggot and the clover-root mealy-bug. A number of complaints have been made of injury by insects which lead to the belief that the seed-corn maggot is frequently found on beets, although instances which could be positively traced to this species are comparatively few.

THE CLOVER-ROOT MEALY-BUG.

(*Dactylopius trifolii* Forbes.)[a]

This species, as its common name indicates, is better known as an enemy of clover, on the roots of which it feeds. In 1901, however, it appeared in considerable numbers on sugar beet in Michigan, the smaller stunted roots being invariably infested. Injury was most apparent in June. The female mealy-bug measures a little more than one-twelfth of an inch in length, is reddish brown, and covered with a waxy or mealy secretion. The legs are dirty yellow, and from the sides project in the manner usual to this group 15 to 17 waxy filaments, the shortest being near the head and the longest near the tail, sometimes one-third as long as the body. It is related to the scale insects and is of similar appearance to the species shown in figure 63.

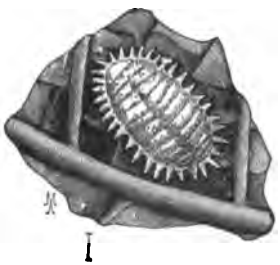


FIG. 63.—*Dactylopius citri:* female—enlarged (Division of Entomology).

Remedies.—The same methods of control that have been prescribed for root-lice would operate against the present species, with about the same results.

THE SEED-CORN MAGGOT.

(*Pegomya fusciceps* Zett.)[b]

Beet roots are subject to attack by the above-named species of root maggot. During November of 1902 we received complaint of what was with little doubt this insect from Colorado, where it was breeding in rot-infected roots, apprehension being expressed that

[a] Syn: *Coccus trifolii* Forbes; 1st Ann Report State Ent. Ill. for 1884 (1885), pp. 72–73; Pettit: Bul. 200, Mich. Agr. Exp. Sta. for 1901 (1902), pp. 193–194; Davis: Insect Life, Vol. VII, p. 172.

[b] See Bul. 33, n. s., Div. Ent., pp. 84–92, for synonymy, bibliography, etc.

although injury was not then noticeable the insects might do damage the following spring. Such a sequel is often to be expected, and it seems probable that many reported instances of injury by this and related forms of maggots are due to their habit of developing on decaying vegetable and other matter and afterwards attacking roots and taproots and other healthy vegetation of the vicinity. Most vegetables, more particularly beans, peas, and maize, are subject to damage, and cabbage, turnip, radish, onions, and sweet potatoes are also much affected. The insect which is generally distributed in the United States is shown in its different stages in figure 65. It resembles the beet or spinach leaf-miner previously considered. The particularly distinguishing characteristic of the fly consists of a row of short bristly hairs of nearly equal length on the inside of the posterior tibiæ of the male (fig. 64, *a*). The length of the wing is about one-fifth and of

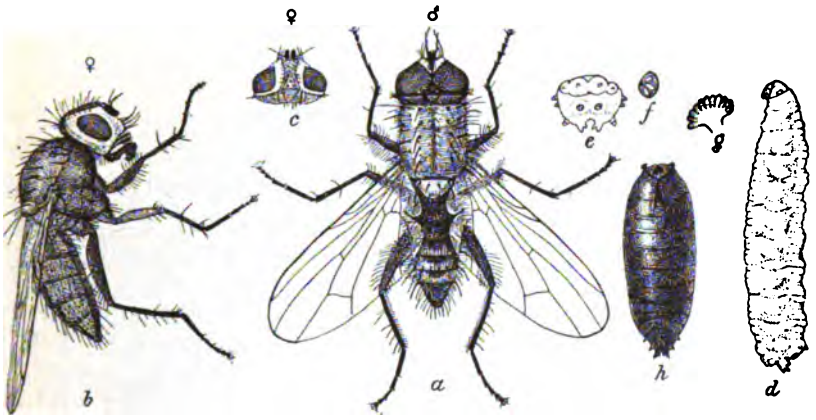


FIG. 64.—*Pegomya fusciceps:* *a*, male fly, dorsal view; *b*, female, lateral view; *c*, head of female, from above; *d*, larva, from side; *e*, anal segment of larva; *f*, anal spiracles; *g*, thoracic spiracles; *h*, puparium—all much enlarged (author's illustration, Division of Entomology).

the body about one-sixth of an inch. The maggot as well as fly resembles the onion maggot. There is little doubt that this insect is of European origin, and it is certainly increasing in destructiveness in this country.

Remedies.—Owing to the difficulty of destroying subterranean pests and the cost of chemicals for the purpose, such as bisulphid of carbon, we have to depend more upon methods of prevention. One way of deterring the parent flies from depositing their eggs consists in the use of sand soaked in kerosene—a cupful to a bucket of dry sand—which is placed at the base of the plants, along the rows. This also kills young maggots that may attempt to work through the mixture.

Fertilizers are also useful as deterrents, particularly when employed just before or after a shower has thoroughly wet the ground. They should be applied as nearly as possible to the roots, and the earth

should be turned away from the plants for this purpose. They possess the advantage of also acting as a stimulant to plant growth. Stable manure is apt to induce infestation, as this species is well known to develop in excrement and other decomposing material. As soon as plants show signs of wilting and maggots are known to be present, the injured plants should be promptly pulled and destroyed.

The above methods have been used with success against onion maggots and similar root-feeding species, and may be all that is required in the case of ordinary infestation of beets.

One of the best remedies for root maggots is bisulphid of carbon. It has been used with more or less success by Prof. A. J. Cook and others since 1880. In its application great care should be exercised that the liquid shall not come in direct contact with the roots of the affected plants. Directions for the treatment of plants affected by root maggots are furnished on page 14 of Farmers' Bulletin 145, a copy of which can be had upon application to the Secretary of Agriculture.

THE RED SPIDER.

The common or two-spotted red spider (*Tetranychus bimaculatus* Harv.) is usually present in most fields of sugar beet east of the Rocky Mountain range, but it is preeminently a greenhouse pest, and as a rule does comparatively little injury to plants growing out of doors. It is unique as a vegetable pest in that it is not a true insect, nor even a spider, as the popular term would imply, but a spinning mite. As the word mite indicates, these creatures are extremely minute, and are frequently not noticed until they become excessively numerous, as is apt to happen during summer droughts. They do considerable damage in flower and vegetable gardens, but attain their greatest destructiveness in connection with plants grown under glass.

The general appearance of the common red spider is shown in figure 65, highly magnified. The length of a full-grown individual is only about one-fiftieth of an inch. The ground color is reddish, usually more or less tinged with yellowish or orange, and most individuals have a dark spot on each side, due to the food contents of the body. The young are similar to the adults, differing in having only three pairs of legs, while the adults have four. This red spider spins threads, but does not use them for climbing. The threads are frequently so numerous as to form a tissue visible at a little distance. Webs are usually constructed on the under sides of leaves and within them the mites feed and lay their eggs from which the young develop.

This red spider is quite likely of foreign origin, but its distribution has not been carefully studied.

It is inclined to be omnivorous, attacking a wide range of plants. As the red spiders increase in number the leaves of an affected plant

turn pale and become stunted, and eventually the whole plant succumbs unless remedies are applied. Cuttings and young rooted plants are especially susceptible to injury, and more particularly in spring. These mites injure by suction, slowly reducing the vitality of plants until in time their functions are more or less deranged. Among ornamental plants that are much affected are violet, rose, clematis, minuet, pink, fuchsia, pelargonium, godetia, passiflora, feverfew, thunbergia, verbena, heliotrope, moonflower, calla, smilax, and Easter lily; while of other crops, beets, beans, sage, tomato, eggplant, pepper, cucumber, squash, cowpea, hops, and berries of various kinds are attacked. As a rule this species is not especially harmful to the sugar beet but is quite destructive at times in fields of other crops; for example, to beans, which have been badly injured in South Carolina in recent years.

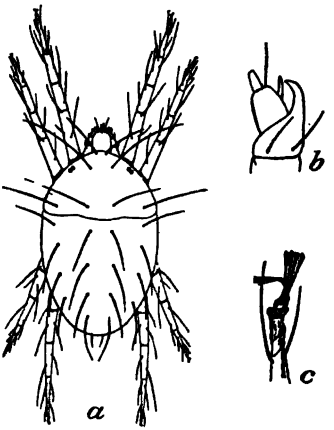


FIG. 65.—*Tetranychus bimaculatus:* *a*, adult; *b*, palpus; *c*, claws (after Banks, Division of Entomology).

Remedies.—This red spider is resistant to "gassing" or fumigation, either with tobacco or hydrocyanic-acid gas. It is, however, peculiarly susceptible to sulphur, a sovereign remedy for mites in general. Flowers of sulphur mixed with water at the rate of 1 ounce to the gallon and sprayed over the plants is of great value in its eradication; or the sulphur may be combined with a wash, for example, with strong soapsuds.

Potash, fish oil, whale oil, and other soap solutions, resin wash, and kerosene-soap emulsion are also valuable, and the addition of sulphur increases their effectiveness; but these washes are too strong for some delicate plants and are apt to injure them. For violets and similar plants, as they occur in greenhouses, no other remedy is used by florists generally than frequent syringing or spraying with water or with a solution of neutral soap. Directions for the application of the soap washes to violet and other greenhouse plants are furnished in Bulletin 27, new series, of the Division of Entomology (pp. 40–42).

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U. S. DEPARTMENT OF AGRICULTURE.

Report no. 75 Sugar Industry rep.
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Report No. 75.

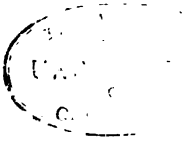
INDIAN CORN IN ARGENTINA:

PRODUCTION AND EXPORT.

BY

FRANK W. BICKNELL,
SPECIAL AGENT.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.



ARGENTINA: PROVINCES, RIVERS, RAILWAYS, AND PRINCIPAL CITIES.

U. S. DEPARTMENT OF AGRICULTURE.

Report No. 75.

INDIAN CORN IN ARGENTINA:

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1903.

ARGENTINE TERMS, WEIGHTS, AND MEASURES USED IN THIS BULLETIN.

METRIC SYSTEM.—The metric system of weights and measures is used exclusively in Argentina, except that certain local terms are still somewhat in use, but not officially.

MONEY.—Unless otherwise stated, expressions of value used herein have been converted into United States money. The Argentine gold dollar, or peso, is worth 96.5 cents in United States money. The Argentine paper dollar, in common use, is worth about 44 cents.

KILO.—The short word for kilogram, the metric weight equal to 2.2046 pounds avoirdupois.

HECTOLITER.—A metric measure of capacity equal to 3.531 cubic feet, or 2.8377 bushels, or one-tenth of a cubic meter. It is the standard used to express the specific weights, and thereby the quality, of grain.

TON.—The metric ton is equal to 2,204.6 pounds avoirdupois, or 39.36 bushels of shelled corn.

QUINTAL.—100 kilos, or 220.46 pounds.

METER.—39.37 inches.

KILOMETER.—0.621 mile.

HECTARE.—2.471 acres.

SQUARE.—4.17 acres.

LEAGUE.—6,672 acres.

CHACRA.—A farm devoted exclusively to agriculture.

CHACARERO.—A man who works a farm to raise crops.

ESTANCIA.—A stock ranch.

ESTANCIERO.—A man who owns an estancia, and generally the one who operates it.

PATRON.—The proprietor, the owner of the land rented to "colonists;" the employer of labor, or the head of the establishment on any kind of a farm.

COLONIST.—A renter of land for agricultural purposes, usually a foreigner, hence the term.

CAMP.—The term generally applied to the country, derived from the Spanish word "campo," meaning country. It has another meaning, applied to the land or pastures. A man will say, for instance: "My camp is in good condition."

TROJA.—Corresponds to our corn crib. It is made by setting strong poles in the ground and weaving canes and corn stalks through them to make a circular crib, to hold corn in the ear. Being loosely made, air can pass through the corn. Sometimes it is covered, but more often not.

CANALETAS.—Chutes, made in sections and hung on wire cables stretched from warehouses on the high banks of the Parana River to the ships lying in the stream below. Ships drawing 26 feet of water could be loaded in Rosario and other ports in this manner at trifling expense, but they can not load to more than 18 feet, as a rule, because of the bars in the river below. Besides the temporary canaletas, on cables, permanent chutes for the same purpose are also built on the banks all along the river. Bags of grain, yerba, or flour, bales of hay, tobacco, dried meat, and other cargo slide into the ships in this manner at small cost. This economical method will all be done away with in Rosario when the new port is built, hence shippers are planning to go elsewhere.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., November 25, 1903.

SIR: I have the honor to submit herewith a report upon the production of Indian corn in Argentina and its exportation from that country. The investigation from which this report comes originated in some inquiries addressed to me in December, 1901, by Mr. Frank H. Hitchcock, then Chief of the Division of Foreign Markets of this Department. It was found profitable and necessary to a full understanding of the subject to enlarge the investigation so as to include the methods of production as well as the manner of exportation. The climate of Argentina also is a subject of interest in this inquiry, and a careful statement of climatic conditions, with comparisons with the United States, is presented. Two weather maps, one showing the annual isothermal lines and the other the distribution of rainfall, will serve to illustrate the statement.

The map of the corn district of Argentina accompanying this report gives the railway lines and rivers by which the surplus corn crop of the country is moved for export.

The information here presented will, I believe, be useful to many farmers and business men, and I suggest that it be printed as one of the reports of this Department.

Acknowledgment should be made for generous and valuable cooperation of officials, grain men, and farmers in Argentina in the prosecution of this inquiry. Among the many who were of assistance, special acknowledgment and thanks are due to Señor Don Ronaldo Tidblom, director of agriculture and animal industry; Mr. Russell Smith, inspector of hay, etc., for the British Government, now at the head of the commercial grain and hay inspection service for export from Rosario, Buenos Ayres, Bahia Blanca, and other places; Mr. J. Collett-Mason, estanciero of San Jose de la Esquina, Province of Santa Fe; Señor Eduardo E. Brett, Pehuajo; Mr. W. S. Martin, Rosario; Mr. W. G. Davis, director of the national weather bureau, and Mr. H. B. Coffin, Carcaraña.

Respectfully,

FRANK W. BICKNELL,
Special Agent and Agricultural Explorer.

Hon. JAMES WILSON,
Secretary.

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INDIAN CORN IN ARGENTINA: PRODUCTION AND EXPORT.

INTRODUCTION.

[For Argentine terms, weights, measures, etc., see back of title page.]

The methods, or lack of methods, in growing and harvesting Indian corn in Argentina have a great influence on the success of the exporting business. All these differ widely from our own methods, even more than Argentine corn differs from ours. But progress is to be expected in Argentine corn growing, which is now a separate occupation, not usually carried on by one man in connection with other crops. More and better home use is likely soon to be made of the corn they produce there, and instead of sending the greater part of the increasing crop out of the country, Argentina will in the near future use much of its surplus corn to fatten cattle and hogs for domestic consumption and for export.

THE CORN AREA OF ARGENTINA.

In 1902 the area reported planted in corn in the entire Argentine Republic was 4,433,686 acres, but of this 3,963,897 acres were in the four provinces of Buenos Aires, Santa Fe, Cordoba, and Entre Rios, chiefly in the first two named. (See Pl. I.) The area within which corn is now grown successfully and as a serious business is roughly bounded by a line drawn around points distant from the city of Buenos Aires about as follows: To the south 225 miles and to the west 250 miles, all in the Province of Buenos Aires; to the northwest 325 to 350 miles, into the Provinces of Santa Fe, and Cordoba, and to the north 350 miles, into the Province of Entre Rios. Still, a great majority of the best corn is grown within a much smaller area than this—within 75 to 150 miles of the Parana River and within the same distance of either Buenos Aires or Rosario, the chief corn markets.

Outside the corn district just outlined, for 100 miles or more to the south, west, and north, corn is raised and will be raised in increasing quantities every year. Many parts of the great Territories of the Pampa and Neuquen, to the southwest, and of the Province of San Luis, to the west, are showing unexpected agricultural value. Land in San Luis and northern Pampa has had a tremendous boom during the past year, being wanted chiefly for alfalfa pastures on which to fatten cattle.

The cultivation of corn is a settled business in only a few localities where the greatest yields are secured. Otherwise it is unsteady and uncertain, depending upon the whims of large landowners who may decide to "colonize their camp with maize"—that is, plow up the pastures and put the land into corn, or turn out the wheat raisers and bring in corn raisers.

Wheat growing is going south, leaving the Province of Santa Fe, where it was first introduced, and is being succeeded by alfalfa, corn, and stock raising. This is extending more and more to the north, where colonists have been slow to believe they could grow corn successfully. One obstacle in the way of the country's development is that the farmers or "colonists" are not progressive, being mostly very illiterate persons, who never did any farming before they came to Argentina. They do not read and are very slow to make any experiments or adopt anything new. So it is not always easy to get colonists who have had any experience in corn raising to put in the first crop. Very low rents and favorable conditions are offered at first to get colonists to show what can be done with the land. In other words, corn raising in Argentina is still in the experimental stage, with its possible extent and importance very imperfectly realized.

Most of the corn grown in Argentina is raised north of latitude 36 south and largely in latitudes 35 to 33 south, while the corn belt of the United States is in latitudes 38 to 42 north—that is, the best cultivated corn region of Argentina ends now at a point more than 100 miles nearer the equator than that of the United States begins. There are, to be sure, marked climatic differences in the corn regions of the two countries.[a] Most of the temperate zone in Argentina south of latitude 36 south is considered too dry for corn, but this claim is not well established. Superior wheat is grown there, and already it has been found that in some parts at least corn makes a good showing.

With the present prospect that Argentines will soon begin to feed corn to cattle, that they will have hogs to fatten in the same way, and that the methods of corn production will improve, it is reasonable to expect that the production of corn will continue to increase very rapidly in Argentina. The profits of corn raising are sufficient, as the conditions and markets now are, to satisfy the man who works and plans as he should. If the additional inducements of profit from feeding and the good results of better culture are made clear to him, he may be confidently expected to take advantage of the rich opportunities presented by the fertile soil of Argentina. The exportation will, after a few years, not increase in proportion to the increased production. Feeding may be expected to consume an increasing quantity.

[a] See p. 10, under heading "Climate of Argentina."

PROSPECTIVE INCREASE OF SMALL FARMS.

Hardly any one thing has interfered more with the development of the Argentine Republic than the fact that most of the good land has been parceled out to a few favorites, at various times, in immense tracts. Until recently it has been difficult for a poor man to get a small tract of land for his actual use and occupation. He could rent, but he could not own. This is gradually changing, though a vast portion of the country is still owned in large blocks by men who are doing nothing to develop it and will not sell at reasonable prices to those who will. The land pays them handsome incomes for grazing and they prefer to hold it for higher prices. But as the country grows older families and estates divide more than formerly. Many colonies have been established and some of the big land companies and farming companies are selling off their land in small parcels. This is being done with the great Curamalan property of 300 leagues, or over 2,000,000 acres, owned by an English company which secured the land thirty or forty years ago from the Government at a very low price under an agreement to stock and operate it.

Mixed farming, as practiced in the United States, is almost unknown. But the country is developing in that direction as land increases in value. It is generally stated and believed that small owners are gradually becoming more numerous, as sales of lands and other evidences, especially systematic colonizing, indicate it. It is not supported by published statistics, however.[a] The need and benefit of having farmers who own their land, propose staying in one place permanently, and have an interest in the country is being better understood every year.

[a] Statistics published each year by the Argentine Department of Agriculture give the number of cereal farmers classified as to renters and owners. The information upon which these statistics are based comes from the thrashing-machine operators, and is no doubt incomplete and only approximately accurate. It probably has not included anything like all the corn raisers, but it is suggestive of the relative numbers of renters and owners. Condensed and compared with the farm statistics of the United States Census of 1900, these statistics show for four years as follows:

	1898–99.	1899–1900.	1900–1901.	1901–02.	U. S. Census, 1900.
Owners	13,415	15,013	13,815	13,060	3,713,371
Cash renters	15,690	14,290	14,715	18,819	752,920
Share renters	6,284	5,100	5,537	5,465	1,273,366
Total farms reported	35,389	34,403	34,067	37,344	5,739,657
Percentage of owners	37.91	43.64	40.55	34.97	64.69

The statistics for 1901–02 are not quite complete, having been published before the last of the reports had been received, so the number for that year should be slightly increased.

IMMIGRATION.

The Government is very willing to encourage and assist immigration and colonization, in many practical ways. Owing to causes which they are now trying to study out, immigration has fallen off during the past year or two, and often the monthly balance is against the country—more going out than coming in. Many reasons are assigned for this condition of affairs. Complaint is made that the administration of justice is not what it should be, especially in the country, and that a poor foreigner has not much chance; that he is likely also to be burdened with oppressive taxes. Many Italians come to the country to work a few months, in the harvest, and then go home or to North America. The great prosperity and industrial activity in the United States has also had much to do with diverting European immigration from Argentina to this country. Immigrants are learning that Argentina is a poor place for a man without some capital, unless he is willing to live on very little at first and undergo many hardships. The country is, nevertheless, giving opportunity to Russians, Armenians, Boers, and drought-stricken Australians, all of whom are bettering their condition by engaging in agriculture.

CLIMATE OF ARGENTINA.

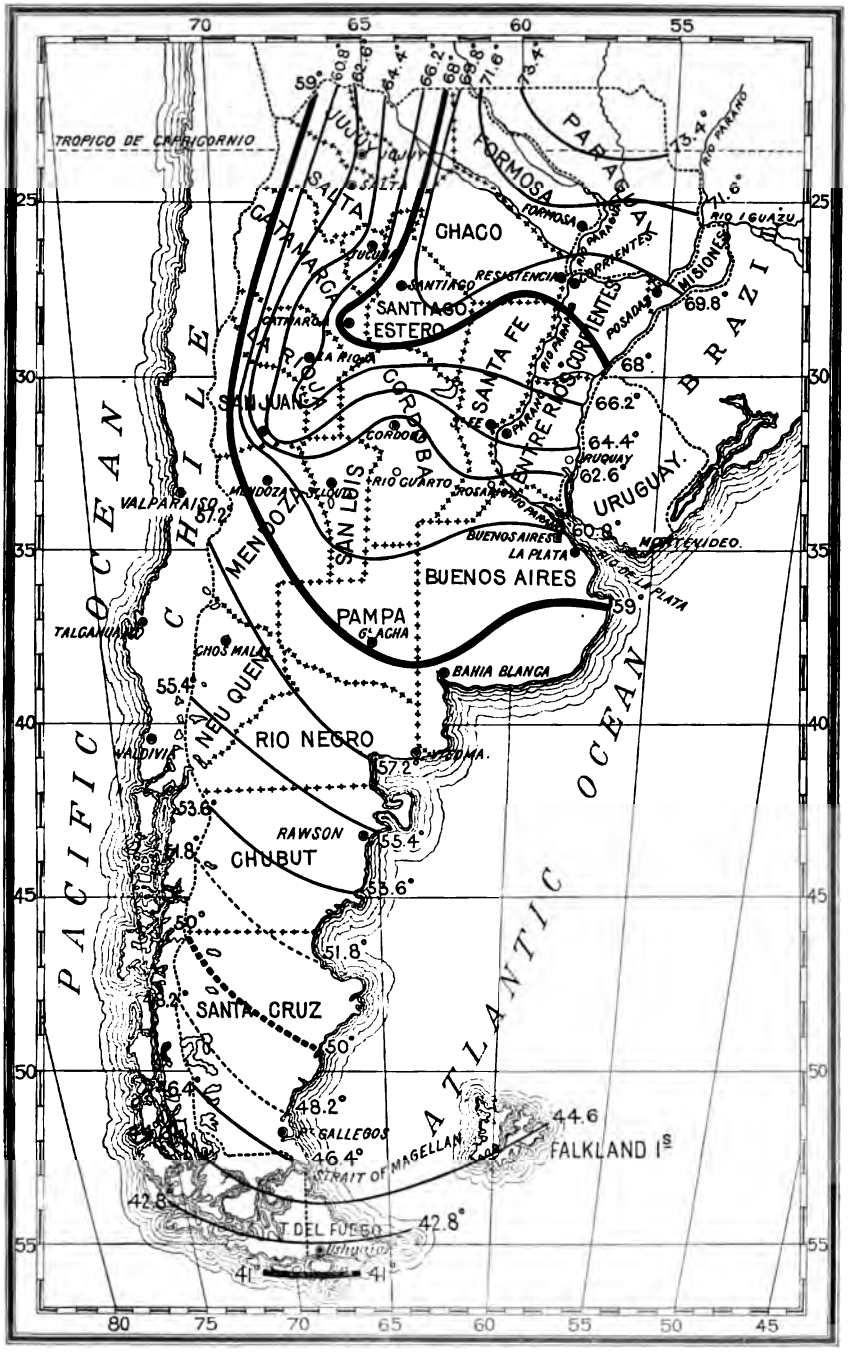
"What is the climate of the country?" is a question often asked about Argentina. Almost any desired climate, from tropical to frigid, may be had in a country that extends through more than 34 degrees of latitude, or more than 2,300 miles, from latitude 22 to 56 south, and is in places 800 miles wide. (See Pls. I and II.) Conditions vary widely in the same latitude. Rainfall diminishes from the east to the west until the very base of the Andes is reached. (See Pl. III.) Temperature is highest in the central part of the country, falling rapidly in the Andean region to a point many degrees below the temperature of localities due east, in the Litoral, which is the name given to the region including the Territories of Formosa, the Chaco, and Misiones, and the Provinces of Corrientes, Entre Rios, Santa Fe, and Buenos Aires, the best part of the country.

The second climatic division of Argentina is known as the Mediterranean region, embracing the central part of the Republic, from the Bolivian frontier on the north to the southern extremity of the continent, and the Atlantic coast to the south of the Province of Buenos Aires.

The third division is called the Andean, and comprises the region west of the Mediterranean and includes the eastern slopes of the Andes.

The highest recorded temperature,[a] 120°, was during the hot wave

[a] The centigrade thermometer is used in Argentina, but all expressions of temperature in this bulletin have been converted into Fahrenheit.



ISOTHERMAL LINES, SHOWING ANNUAL AVERAGES OF TEMPERATURE IN ARGENTINA.

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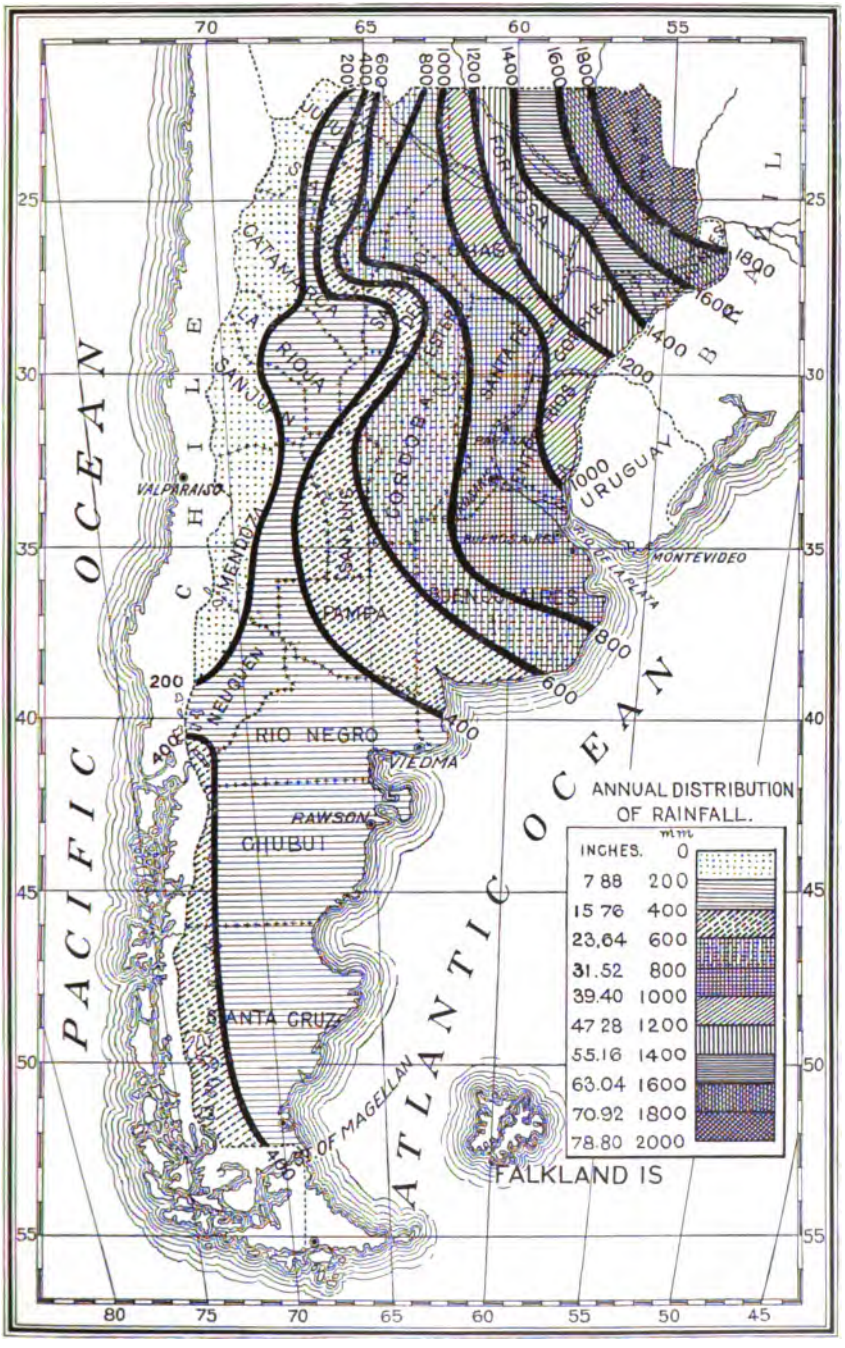

RAINFALL IN ARGENTINA, ANNUAL DISTRIBUTION, VARIOUS REGIONS.

in February 1900, in the Province of Catamarca at the extreme north, and the lowest recorded temperature was 3°, in the southern extremity of the continent, a range of 117° of temperature in 33 degrees of latitude. The Argentina weather bureau states, however, that lower temperatures are probably experienced in the interior of the Territory of Santa Cruz. In the northern part of the Litoral the ordinary range of temperature is from 41° to 106° and in the southern section of the Litoral the usual limits are from 32° to 102°. This is the Territory in which most of the corn is raised, and the summer temperature averages from 72° to 77° and is rarely above 96°.[a]

A very good system of weather reports has been organized by the Argentine Government under the direction of Mr. Walter G. Davis, formerly a resident of Vermont, who has been in this service in Argentina for the past twenty-six years. The national telegraph service, which is part of the postal system, carries the reports, and the operators, in many cases, are observers. The best instruments have been supplied to observers and the national telegraph lines have been extended well over the country, so that now observations are reported and the conditions are being studied in the remotest sections. In the hands of the capable director the service is well organized and efficient. Weather maps similar to those issued in this country, are published daily by the Weather Bureau in Buenos Aires.[b] The temperature of the various parts of the country is shown by the isothermal lines as follows:

SUMMER.

The summer isotherm[c] of 77° starts on the Uruguay River in about latitude 31 south, runs through the upper edge of the Province of Entre Rios, through central Santa Fe, and downward to the city of Cordoba, where it dips south to the lower part of San Luis and Mendoza, and from there turns upward along the lower slopes of the Andes to Bolivia.

The summer isotherm of 75° begins at about latitude 33 south, runs west across the lower part of the Province of Entre Rios; thence southwesterly through the city of Rosario, across the southern edge of Cordoba and San Luis, the northwestern corner of the Pampa, and then

[a] The average annual temperature of the corn belt of the United States is about 50°. The season averages in Iowa are: Winter, 20.9°; spring, 47.3°; summer, 72.3°; autumn, 50.1°. The corn belt lies between the isothermal lines of 45° and 55°, annual.

[b] These maps have only been published a little over a year, and the service is not entirely perfected in the more distant parts of the country.

[c] The temperatures used to form the isothermal lines have been reduced to the level of the sea at the rate of 1° Centigrade to each 200 meters of altitude, or 1.8° Fahrenheit for each 656 feet. The corn region is scarcely affected by this operation, since it is nearly all less than 200 feet above sea level.

up through Mendoza, San Juan, La Rioja, Catamarca, and Salta to Bolivia.

The isotherm of 73° begins in about latitude 33.5 south and crosses the northern part of the Province of Buenos Aires, takes a southwesterly course through the central part of the Territory of the Pampa, and makes a curve from the central part of the Territory of Neuquen upward to about latitude 35 south.

The line of 72° starts at Buenos Aires, latitude 35 south, and follows a general southerly direction across the Province of Buenos Aires, the southwestern corner of the Pampa, the northwestern corner of Rio Negro and central Neuquen to the Andes.

The line of 70° starts at the seacoast in latitude 37 south, runs southwest along the coast to latitude 40 south, whence it crosses the Territory of Rio Negro, dipping a little to the south, and up a trifle north of latitude 40 south in Neuquen.

Autumn temperatures average in the temperate zone about 11 degrees cooler than summer.

WINTER.

The winter isotherm of 70° runs from the southeast corner of the Territory of Misiones, in latitude 27 south, to lower Catamarca, in almost a straight line, thence north to Bolivia.

The line of 57°, beginning in latitude 30.5 south, crosses lower Corrientes, central Santa Fe, northern Cordoba, south to the city of San Juan, and north to Bolivia.

The line of 55°, beginning in latitude 31 south, runs across Entre Rios to the city of Santa Fe, a little north to the city of Cordoba, southwest to the city of San Luis, through Mendoza northwesterly, and north to Bolivia.

The isotherms of 54° and 52°, beginning in latitudes 32 and 33.5 south, respectively, are nearly parallel with line 55°.

The isotherm of 50° begins at about latitude 34.5 south, a few miles north of the city of Buenos Aires, runs northwest to the middle of the lower point of Santa Fe, thence southwesterly along the borders of Buenos Aires, the Pampa, Cordoba, and San Luis, and upward through Mendoza to about the same latitude as that of the starting point.

The isotherm of 48° starts on the coast at about latitude 35.5 south and dips downward through the Province of Buenos Aires to a point about 50 miles north of Bahia Blanca, where it crosses the Pampa and Neuquen on a slight upward incline, ending in a sharp upward turn to latitude 37 south.

Below this the lines are more nearly east and west, both summer and winter. At latitude 39.4 south the winter temperature is 46.4°. At latitude 44 south it is 43°.

The spring temperatures average about 11° to 12° warmer than the winter temperatures.

ANNUAL AVERAGE TEMPERATURE.

The highest annual average is 75°. This is in the northern part of Formosa and Jujuy, near the Tropic of Capricorn. At every 70 to 150 miles south the temperature is about 2 degrees cooler. The line of 66°, annual average, runs straight across the northern part of Entre Rios, central Santa Fe, and downward to the cities of Cordoba and San Luis, curves downward 50 miles south of the city of Mendoza and up to a point on the boundary due west of the last-named city. The isotherm of 63° goes across lower Entre Rios, just south of the city of Rosario and due southwest along the borders of Buenos Aires, Cordoba, San Luis, and the Pampa to Chos-Malal. At La Plata the isotherm of 61° begins and runs a little north to central northern Buenos Aires, where it bears off to the southwest, through the Pampa a little south of the center, into Neuquen. Bahia Blanca is in the line of 59° and from this point the lines are more nearly uniform, the temperature being about 2 degrees warmer on the Atlantic coast than at the base of the Andes. It averages about 2 degrees lower each 125 to 150 miles south until at the end of the continent, in about latitude 56 south, it is 41°.

The isothermal lines shown in the map given herewith (Pl. II) indicate average temperatures for the year from actual observations, not reduced to sea level. No temperatures taken in deep valleys or on high mountains have been considered, but only those that fairly represent the altitude of the region.

Observations of temperature have been made in the city of Buenos Aires since 1856. They are printed in three periods and the averages are, by seasons, as follows:

Average temperatures at Buenos Aires.

Season.	1856–75.	1876–96.	1897–1900.
	°F.	°F.	°F.
Summer (December, January, and February)	74.3	72.5	75.3
Autumn (March, April, and May)	63.1	61.5	64
Winter (June, July, and August)	51.9	51	51.4
Spring (September, October, and November)	62.6	61.3	61.5
Year	62.9	61.5	63.1

These averages are not far from the averages of the principal corn regions, being but a trifle cooler than the northern part thereof.

EFFECT OF HUMIDITY ON TEMPERATURE.

Though the temperature of the warmer part of the present best corn area, southern Entre Rios, Santa Fe and Cordoba and northern Buenos Aires, is not often above 96°, it seems 15 or 20 degrees hotter most of the time because of the high percentage of humidity. In the city

of Cordoba, the altitude of which is 1,000 to 1,200 feet higher than the farming country below, the average annual percentage of relative humidity is 64. In Buenos Aires and Rosario it is 78.[a] In the northern part of the Litoral, the Territories of Misiones, Formosa and the Chaco, and the Province of Corrientes, the relative humidity is 10 per cent greater. The report of the Argentine Weather Bureau contains the following concerning the effects of humidity:

It is not an uncommon occurrence in summer that the temperature of the air, during the hottest hours of the day, is considerably higher in the region of Chubut and Rio Negro than in Corrientes or the Chaco, 16 to 18 degrees nearer the equator. In the first-named region, however, one scarcely feels the heat; whereas, in the latter, the temperature is very oppressive. This is explained by the fact that the temperatures of the wet bulb thermometer are much lower in the southern territories, when these phenomena are observed, than those recorded in the northern region. In the city of Buenos Aires a temperature of 95° is very rare, while in Cordoba it is not exceptional in autumn and spring, and is frequently observed during the summer. In the first-named place this degree of heat causes a suspension of all labor that can be postponed, while in Cordoba it does not give the impression of being excessive, and work is carried on without inconvenience.

WIND.

The effect of winds on temperature in Argentina is stated by Director Davis, of the Argentine Weather Bureau, as follows:

The north winds are hot, and the increase in the heat is, as a rule, proportional to the duration of the wind from this direction, while the south winds are cool, refreshing the air and relieving the suffocation produced during the successive days of north wind. In the Andine region the dry and hot winds are called zondas, which generally blow from north to northwest, and at times with such intensity that respiration is difficult. These winds rise about midday and last till sunset, but at times they last two or three days without interruption, being strongest in spring in the months of September and October. The changes of temperature after a severe zonda and the south wind which follows it are frequently as high as 45°. In the Litoral and Mediterranean the heat produced by the north wind generally terminates with a thunder storm or pampero. The pamperos in the Litoral are more frequent in winter and spring. The change of temperature caused by the two winds is frequently from 27° to 36°.

RAINFALL.

The average annual rainfall in the corn district of Argentina is 31.52 to 39.40 inches, and it is quite evenly divided between the seasons.[b]

[a] The average annual percentage of relative humidity in Iowa for the past 25 years has been 70 per cent, and for the crop-growing period, May 1 to September 1, it has been 69 per cent.

[b] The surplus corn States of the United States have an average of about 35 inches of rainfall, the range being from 27 inches in the northwestern part of the belt to 40 inches in the southeastern part. The average for Iowa is 31 inches for the whole State, of which amount 70 per cent falls in the six crop months, April 1 to October 1, and over 50 per cent in the four months, May 1 to September 1. By seasons, the State averages are: Winter, 3.32 inches; spring, 9.19 inches; summer, 12.02 inches, and autumn, 6.53 inches.

From October to March is called the wet season, and from April to September the dry season, in that part of Argentina north of latitude 38 south.

In Buenos Aires 56 per cent of the annual rainfall is in the wet season; in Corrientes 65 per cent of the rain falls in the wet season; in Cordoba 86 per cent, and in Salta 96 per cent. In the region south of latitude 38 south the distribution of rainfall is very even through the year. Snow falls every year in the Territories of Santa Cruz, Chubut, Rio Negro, and Neuquen, but it rarely reaches the Province of Buenos Aires.

The average annual rainfall in a number of representative localities is given herewith:

Average annual rainfall in Argentine cities.

Station.	Latitude.		Longitude.		Years of observation.	Rainfall.
	°	′	°	′		*Inches.*
Villa Formosa	26	12	58	6	1879 to 1892	57.14
Corrientes	27	28	58	50	1876 to 1900	49.28
San Lorenzo	28	10	58	45	1892 to 1900	35.16
Goya	29	9	59	16	1876 to 1900	38.31
Monte Caseros	30	14	57	38	1893 to 1900	40.65
Concordia	31	23	58	4	1876 to 1878 and 1887 to 1898	42.05
Parana	31	44	60	31	1875 to 1882 and 1896 to 1898	35.45
Uruguay	30	30	58	13	1895 to 1899	45.49
Carcarañia	32	49	61	8	1889 to 1900	35.14
Rosario	32	57	60	38	1875 to 1880 and 1888 to 1900	37.46
Buenos Aires	34	37	58	22	1861 to 1900	36.76
Estancia San Juan	34	49	58	3	1867 to 1900	42.57
Dolores	36	18	57	40	1889 to 1900	32.32
Maipu	36	51	57	53	1888 to 1900	26.77
Azul	36	45	59	50	1888 to 1900	32.29
Tandil	37	17	59	8	1888 to 1900	32.47
General La Madrid	37	13	61	16	1888 to 1900	25.73
Bahia Blanca	38	45	62	11	1860 to 1883 and 1896 to 1900	20.58
La Carlota	37	10	63	50	1891 to 1900	21.53
Rawson	43	17	65	5	1880 to 1888 and 1896 to 1900	9.46
Salta	24	46	65	24	1873 to 1897	22.08
Tucuman	26	51	65	12	1873 to 1900	38.02
Santiago del Estero	27	48	64	16	1873 to 1890	19.57
Cordoba	31	25	64	12	1873 to 1900	27.48
Rio Cuarto	33	7	64	19	1881 to 1882 and 1900	26.46
San Luis	33	19	66	20	1874 to 1877	21.57
Catamarca	28	28	65	55	1881 to 1900	12.67
La Rioja	29	19	67	1	1875 to 1892	10.78
San Juan	31	32	68	31	1875 to 1900	2.93
Mendoza	32	53	68	49	1866 to 1880 and 1885 to 1900	7.08
Chos-Malal	37	27	69	49	1892 to 1896	7.52
Ushuaia	54	52	68	7	1876 to 1885	23.15
Isla de los Estados	54	23	63	47	1886 to 1893 and 1899 to 1900	54.06

The distribution of rainfall throughout the country is graphically shown by the chart (Pl. I), which was made by the Argentine Weather Bureau from observations at more than 150 stations well distributed over the country, covering periods from eight to twelve or more years at most of the stations. The observations in the interior of Formosa and the Chaco, and in the region at the foot of the Andes south of latitude 38 south, were not sufficient for a permanent record, but otherwise further observations may not be expected to show changes, says Director W. G. Davis in his report.

The records also show that the rainfall was well distributed through the months and the days of the months. Rain falls, on the average,

42.2 days per year in Corrientes, 39.2 days in Goya, 55.7 days in Concordia, 50.3 days in Parana, 59.2 in Buenos Aires, 82.2 days in Tandil, 53.5 in Bahia Blanca, 70.3 in Cordoba, 68 in Rio Cuarto, and 58.8 in San Luis.

THE PRODUCTION OF CORN.

EXISTING CONDITIONS AND METHODS, AND PROBABLE IMPROVEMENT.

The production of maize, or Indian corn, in the Argentine Republic, while it has been going on for many years, is only now developing into a great industry. It is just growing out of the primitive methods that have been holding it back and which still prevent farmers from realizing much more than half what they might. The results they achieve are due to the marvelous fertility of the soil and the perfect climatic conditions, which, in spite of bad methods, neglect, and general ignorance, give bountiful harvests to men who would utterly fail in the corn belt of the United States if they farmed as they do in Argentina; and these men can not long continue in this manner where they are. Their only natural disadvantage is that they are likely to get too much rain during the gathering season and they may have too little during the growing season; but where they have a range of about five months in which to plant corn and still be reasonably sure of a crop, much of the fear of insufficient rains during the plowing, planting, and growing seasons is taken away.

The methods of cultivation are improving every year, as the corn area extends and the leaven of modern ideas slowly penetrates to the slow-thinking colonist. He would progress much faster in the United States, because he would have the example of better farmers all around him, while in Argentina he sees nothing better than his own miserable efforts, and he is no theorist, to adopt new methods simply because some one has told him to do so. The chances are that he has never seen anything grow before he came to be a "chacarero" on some large place in the new southern country. Never having had any land to work before, never having had room enough to live or a chance to do anything on his own account, he becomes greedy when he sees so much land on which he is free to go, and wants to take far more than he can work well. Every colonist wants at least 100 hectares, equal to 247 acres, and sometimes he succeeds in getting more. This is, however, the usual limit for a family, unless there are several large boys. The rule on some large corn farms is that 25 squares, or about 104 acres, shall be allotted to every able-bodied working hand. Farming as they do, a man can work that amount of land in corn until the gathering is upon him, when he must have help or suffer heavy losses.

FIG. 1.—HUT OF ITALIAN "COLONISTS" IN ARGENTINA.

FIG. 2.—FIELD OF CORN IN ARGENTINA JUST BEGINNING TO TASSEL, ITALIAN COLONIST IN CENTER.

THE FARMER AND HIS HOME.

Most of these "colonists," or renters, are from the north of Italy, and are very industrious and thrifty. They work and live under conditions that would not be endured by the poorest farm hand in our country. Yet they have here a chance that they could not have at home, and most of them become well off in a few years. But a great many of them do not like the country, and are leaving it and returning to Italy or coming to the United States. The reason most commonly given is that they are oppressed by the petty local officers and made to pay excessive taxes and unjust fines. Some of them, however, become citizens and occupy positions of influence among their fellows. Others desire only to accumulate money to live comfortably in Europe. A better class of corn farmers are the Austrians, who are not numerous. They build frame houses and live far better than the Italians, and yet seem to make as much money. The Italian renter builds a mud house with a zinc roof, all the materials being furnished by the "patron," the owner of the land. Several hard-wood posts are set in the ground and small boards nailed across the top. The sheets of zinc are then spread over the frame for a roof, with a slight pitch. Wire is tied from post to post and cornstalks woven in, the wire holding them up. Mud is plastered on both sides of the stalks and soon dries. A hole is left for a door, and perhaps, but not always, a smaller hole for a window, and the house is done. I made a photograph of one of these dwellings, which was about 12 feet long and 8 feet wide (Pl. IV, fig. 1). Four men and a boy lived in it, and were doing a good business, cultivating something over 400 acres of corn. The head of this gang is the one shown in the picture (Pl. IV, fig. 2) standing in the corn, which at that time, December 22, was about eight weeks old.

LAND RENTING, INCLUDING TERMS, PRICES, ETC.

These men came to the land with nothing but their strong bodies as their capital. The big Italian standing in the corn was the boss and the responsible man, if anyone was responsible. The owner of the land had this contract with them: He gave them the land, material to build the house, plows, harrows, cultivators, planting machines, necessary mules and bullocks to work, and two horses to draw water and ride in caring for the other animals. He became responsible for their credit at the country store for an amount equal to about $12 of our money, per month and they fed themselves, paying the account at the store when they received their share of the proceeds of the crop. One-third of the cost of the seed, harvesting, and shelling was charged to the tenants. They agreed to work the land to the satisfaction of the owner, and for all this they received one-third the proceeds of the sale of the crop, the owner selling when he saw fit. It is on some such

terms as these that the poor man gets his start, and in a year or two he advances to the next stage, where he furnishes everything and delivers to the owner at his warehouse a share of the crop ranging from 16 to 22 per cent—16 per cent the first year, 18 per cent the second, third, and fourth years. Other contracts call for 20 per cent the first year, 21 the second year, and 22 the third and fourth years. This was in a comparatively new district, the advantages of which were not so well known. Higher rents are obtained elsewhere, nearer the Parana River, where the land is known to be very rich and the market is very near. The third step of the corn raiser is the payment of cash rent.

The cash-rent system is the one generally in vogue, though nearly every large "chacra," or farm devoted to agriculture, has all three plans in operation. The prices paid vary greatly, according to location and supposed fertility of the land and its adaptability to corn. The price on the place I am speaking of, which is located 70 miles west of Rosario, was from $5 to $9 per square, which is a fraction over 4 acres. The latter is now the ruling price and it will probably soon be advanced. The lower price was offered when the land was converted from wheat—which was a failure—to corn, to induce the better class of corn farmers from nearer the river to come out there and take the land. Now that its adaptability to corn is established, the owner will doubtless have no trouble to rent it to good men, as renters go in Argentina, for higher prices than he is now receiving. In the best corn lands, near the Parana River, rents have been paid as high as $4.25 an acre, but this is exceptional and above the average, even for the best lands. Half of this rent must be paid in advance and the colonist agrees to use all the land, except 4 per cent for his house, garden, corrals, etc., for corn or linseed; and only 10 per cent for linseed. He agrees to keep out all noxious weeds and he must plow and cross plow before planting, dropping the seed corn behind the plow the last time with a machine attached to the plow. Then he must follow with the harrow, and harrow again after the corn is up, and cultivate once with a single-shovel, one-horse cultivator. Hardly a farmer cultivates his corn more than once, and only one way, but many of them are required by their contracts to go through after cultivating and pull the worst of the weeds.

In other parts of the country, farther south, in the Province of Buenos Aires, rents for corn lands range from $1.50 to $2.50 per acre, depending upon how near the market and how good the land. While most of the corn is raised by renters, the number of small proprietors is slowly increasing.[a] The valuation generally put upon agricultural land is to call the rent 8 per cent of the value. But land can be bought cheaper than this if one knows where and how to go, especially in large tracts. The best farming land in the country has been selling at

[a] See footnote, p. 9.

FIG. 1.—CORN OF DIFFERENT AGES IN SAME FIELD IN THE PROVINCE OF SANTA FE.

FIG. 2.—PORT OF ROSARIO, ARGENTINA, LOWER LEVEL.

prices ranging from $6 to $15 an acre. A tract of 1,943 acres about 75 miles west of Rosario, in an excellent corn district, was sold for $13.75 per acre, $3,500 down and the balance in annual payments at 6 per cent interest. Land within 50 miles of Buenos Aires is worth three to four times as much as this.

THE FARMER'S FOOD AND DRINK.

Formerly colonists were allowed as much as 12 per cent of the land allotted to them, rent free, for pasturage, corrals, house grounds, etc. Now they have to pay for it all, even the 4 per cent which they are allowed for such purposes. But it must not be supposed that the colonists want this land for gardens, for they very seldom have them. Rarely do they raise as much as a cabbage, living on bread and meat and a few potatoes, and perhaps a few other vegetables that they buy. They might have fine gardens, but they are intent on making the land produce all it will that is marketable. Comforts and luxuries are not included in their ideas of life in Argentina. They have two meals a day, at about 11 and 7, with little besides the "yerba maté," or Paraguayan tea, early in the morning. This wonderfully nourishing and muscle stimulating drink is sucked through a tube from a gourd that holds about 4 ounces of water. Boiling hot water is repeatedly poured over the tea leaves in this gourd, and one filling suffices for a dozen fillings of water. The same tube is used by everyone present, even when there is company. It is a very wholesome beverage, in use all over Argentina, and the common people are very much attached to it. Some of them put sugar with it, but it is more wholesome without, though it is quite bitter.

LONG SEASON FOR PLANTING.

Planting of corn may begin as early as August 15, but generally not until three or four weeks later, and it may be as late as January 15, though generally it is not considered quite safe to plant later than December 20. (See Pl. V, fig. 1.) On the 18,000-acre place which I have referred to, at San Jose de la Esquina, some planting was done as late as January 12 this year and a fair crop secured. The early planted corn was ripe at the end of January, but harvesting was not commenced until the latter part of February. Three men came to this place at the end of August and plowed, cross-plowed, planted, and cultivated 400 acres themselves and had a good crop, averaging about 40 bushels to the acre. In adjoining fields may be seen corn in full tassel and corn just out of the ground. Of course the early corn generally has the best chance, because it then gets the full benefit of the hottest weather to mature and ripen. The latter part of the summer is likely to be rainy, and in damp seasons the plants grow to such a size and are so close together that the lower ears do not get sufficient

air or sunshine to ripen or dry out. This results in uneven dryness of ears in the same field. Corn of uneven ripeness is likely to cause trouble and, being deficient in starch and having its sugar imperfectly formed, is inferior in food value, besides being likely to heat and mold and spoil other better grain. The unripe condition of corn exported is not always discovered until it has been sent across the ocean and caused some losses on the voyage. Often late planting is due to drought in the spring, which prevents plowing. Disk plows from the United States are now being introduced to a considerable extent, both among corn farmers and wheat farmers, as they have been found of great value in dry seasons when the ordinary mold-board plows could not be used.

GATHERING, CRIBBING, AND SHELLING.

Farmers are usually in a hurry to get their money and so are apt to gather their corn too soon and have it shelled too soon. Shippers are eager to get cargoes off while the weather is dry, and this stimulates premature marketing. It is in the harvest season that the Argentine farmer has his greatest trials. Almost invariably he has more than he can gather without extra help, and that is difficult to get. Often, to save time and realize on his crop sooner, he arranges to shell directly from the field, rushing his grain to market before it has had any chance to dry. When this is not done—and oftener it is not—the corn in the ear is put into a crib, called a "troja," which is a round receptacle made of poles stuck in the ground with wire and cornstalks woven in among them, making a sort of bin, not always covered. This being more or less open gives the air opportunity to circulate through and dry the corn, especially if the troja is thatched over. They serve the same purpose as our corncribs do. The corn is gathered into sacks in the field and carted to these deposits. It is never husked into a wagon box in the field, as in the United States. The sacks of ears, husked, weigh about 143 pounds, and the men are paid by the sack for husking Ordinarily the men are paid about 8 cents per sack and boarded, or 10 cents per sack and board themselves, but this year the demand for help has been so great, owing to the immense crop, that prices for husking have gone to about 11 cents per sack and board, up to as high as 16 cents per sack without board. A man will gather 8 or 10 bags per day. This year's crop is the largest the country has ever had and prices are very good—about 40 cents per bushel—but the farmers are suffering heavy losses because they have been unable to get men to work in the harvest. Even better prices than those quoted have been offered and the cities are full of idle men, and still the corn is rotting in the fields. These prices for labor may not seem high to a farmer in our country, but farm laborers in the Argentine Republic usually get about $13 a month and their board, which costs their

employers but a very small sum, not more than $4 a month at the most, and usually less. It is estimated that the cost of gathering, shelling, and bagging is about 13 cents per bushel.

Shelling is usually done alongside the trojas, which hold from 1,500 to 8,000 bushels of corn in the ear. Sometimes the corn is shelled at once, without any opportunity to dry, or it may remain in the troja several months. It has been found best by experience that the least possible time should elapse between the time of shelling and loading on shipboard, and the Argentine Department of Agriculture has so advised. "It is better to run the risk of some extra cartage during the winter when the roads are bad," says one man of wide experience, "than to let the grain become heated in bags when deposited in a warehouse." Nevertheless, farmers are more apt to shell their corn as soon as they can get a machine. In many instances the man who runs the machine also buys the grain on the spot, paying 19 to 35 cents per bushel shelled and making no charge for shelling or bagging. Prices for shelling range from 1½ to 2¼ cents per bushel. All corn, as well as wheat, is shipped to market in bags weighing in the neighborhood of 150 pounds. These are coarse burlap bags and are worth about 10 cents each.

MISTAKE OF CLOSE PLANTING.

Aside from lack of cultivation, the principal mistake of the Argentine corn grower is his unwillingness to give his plants room enough to grow and get air and sunshine to mature and ripen. As previously stated, most of the corn is planted with a machine attached to the plow, and the rows are generally about 20 inches apart—simply drilled in, resembling very much a field of fodder corn in this country. A few of the farmers are learning better, and perhaps 100 American corn planters have been sold in Argentina. But no check rowers were seen, and there is so little cultivating corn two ways that it is still spoken of as a curious thing—this "North American checkerboard plan" of planting corn—and scarcely a farmer in the country follows that plan. The Basques, the most industrious and successful class of Spaniards, go in for better methods. The Catalans, from the Province of Catalonia, Spain, are also engaged in corn growing in the Province of Buenos Aires. In some sections, notably to the southwest of the city of Buenos Aires, where some of the best corn farming is done, it is noticeable that the better the farming, the more experienced and successful the farmers, the wider apart the rows are, and occasionally a field is cultivated both ways. The rows in the better cultivated sections are from 24 to 30 inches apart, and the plants in the rows about 20 to 24 inches apart. Corn is hardly ever planted farther apart than this, and the greater part, in fact nine-tenths, is in rows 20 to 22 inches apart, and the plants no farther apart in the rows and generally much closer together.

GOVERNMENT EFFORTS TO SECURE WIDE PLANTING.

The Argentine Department of Agriculture has tried to teach the farmers the benefits of planting farther apart, but they are hard to convince. Men have been sent around in various sections saying to farmers: "Give us a hectare of land and we will plant it and cultivate it the way we think it should be done; we will bear all the expense and you may have all the crop." These experiments have always resulted in producing twice as much, or more than twice as much, as the farmer raised alongside in the old way, because the corn was given plenty of room and was well cultivated. But the ignorant farmers have not always been convinced. When asked how they were going to plant next year, some of them said they intended to go on as before. When asked why, and if they had not seen the good results of the improved methods, they have replied: "Oh, that was just luck; you couldn't do it again." Until recently corn was simply sown broadcast, by hand, covered in some primitive fashion, and nothing more done with it until it was gathered in the fall. Even now much of this is being done in some parts, though not in the districts where corn grows best.

SURPRISING YIELDS.

It is surprising to a North American to see what yields result from such slovenly agriculture. The yields vary greatly in different sections under different treatment and because of varying soils or climatic conditions. There are no complete and reliable crop statistics, such as we have; but, from careful observation and inquiry and from the study of such statistics as are available, very close estimates may be made of the corn yield in various sections. In some places a yield of 25 bushels to the acre is considered fair; but these are outside the preferred corn area and do not represent the best cultivation, even of the Argentine farmer. On the other extreme we find on the rich alluvial lands between Buenos Aires and Rosario, not more than 70 miles back from the River Plate and the River Parana, and in the splendid new country to the west and southwest of Buenos Aires, where the best cultivation is done, the yields run up to 70, 90, and even as high as 110 bushels to the acre. But these are above the average for the average corn country. In the larger part or, say, three-fourths, of the area that may be considered corn country, fairly tested and farmed by the better class of farmers, the average crop is better than 40 bushels to the acre. In the better sections, say one-third of the entire preferred corn area, a conservative estimate would be 50 to 60 bushels to the acre, with many fields showing better results. But beyond the favored "coast district," as it is called, a section about 70 miles wide and perhaps 300 miles long, swerving inland to the west from Buenos Aires and reaching up beyond Rosario, they are learning that proper methods will produce almost, if not quite, as good results.

Places that have rented for 35 to 80 cents per acre and where 23 to 32 bushels an acre was considered very good with simply planting behind the plow, without any cultivation, have shown yields two and three times as great when properly planted and cultivated.

In the future corn production in Argentina is sure to be brought to correspond more nearly with the methods pursued in the United States.

ARGENTINE CROP AND EXPORT IN RECENT YEARS.

At present considerably more than half the corn grown in the country is exported. The statistics prepared by the Argentine Department of Agriculture, the only statistics available, give the area planted in 1901 at 3,473,722 acres and the total yield of the country at 84,018,265 bushels, or an average of 24.18 bushels per acre. Of this crop the custom-house statistics show an exportation of 46,843,282 bushels. Owing to the system of preparing these statistics, this amount is probably slightly in excess of the amount actually exported, but only slightly. This crop was grown between September, 1901, and March, 1902, and 90 per cent of it was marketed between March and October, 1902.

The corn crop of the United States was short in 1901, so it is not fair to use the crop and exportation of that year for comparison. But in 1900 the area planted to corn in the United States was 83,320,872 acres. The total production was 2,105,102,516 bushels, and the average yield per acre was 25.3 bushels. The exportation that year (1900–1901), including corn meal, was 181,405,473 bushels, or 8.62 per cent of the total production, while the Argentine exportation in the calendar year 1902 was 55.75 per cent of the total production. Of course the shortage of the corn crop in the United States in 1901 stimulated prices and exportation from Argentina in 1902, but this is the general rule, that half, or more than half, of the Argentine corn crop is exported when there is a good crop.

In 1902 the State of Iowa alone had 9,302,688 acres of corn, against 3,473,722 acres in the entire Argentine Republic in 1901–02. While Argentina sent out of the country 55.75 per cent, or 46,843,282 bushels of her total production of 84,018,265 bushels, the State of Iowa kept in the county of its growth all but 32,745,462 bushels, or 11 per cent of the crop, which was 297,686,016 bushels. The comparison would be much stronger if we could know the amount of corn shipped away from the place where it was grown in Argentina, but not sent out of the country. It would be at least 80 per cent of the crop and probably more.

This year (1902–03) the acreage of the crop harvested from February to June in Argentina is reported at 4,433,686 acres and the yield, not yet fully reported, is known to be larger per acre than the previous year. Owing to many difficulties this crop has not been

coming to market as fast as it should, yet the shipments up to November 5, 1903, were more than 50 per cent greater than they were up to that time a year before. It is generally estimated by competent persons in Argentina that the exportation this year will be about 75 per cent more than last year.

But at present the production of corn in Argentina is an uncertain business, owing to the difficulties of the harvest and the marketing and to the fact that the value of the crop depends so largely upon conditions in other countries. For instance, the price in 1901 held up high until early in June, when, the reports from the United States being favorable, the price in Europe went down, until it was about the same as it is now, averaging around 40 to 42 cents per bushel for the best in the River Plate markets. Of course it is a good business at that price, and might be much better if the methods of cultivation and harvesting were improved.

PROSPECTIVE INCREASE OF FEEDING CORN TO STOCK.

The most far-seeing Argentines realize that they must adopt the North American policy of sending corn to market on four legs, in the condensed form of beef and pork. One of the best known and most experienced of the farmers and stockmen of the western part of the Province of Buenos Aires, where some of the best corn is raised and a comparatively good class of farming is done, said:

> We have no reliable market for our corn. Europe at any time may take much or none. Brazil and the Cape are progressing too slowly to be of any consequence. We are all therefore extremely careful not to invest all we have in corn. Its future here depends entirely on our ability to provide home use for it. This we are starting to do. A few are planting corn to fatten export cattle and hogs. Most farmers cultivate roughly, one way only, with horse shovels. They have generally no idea of proper distance to plant or how to cultivate. For the most part the farmers are illiterate men who never did any farm work before coming to this country. Under such circumstances it is surprising to see how well they do get on. They are chiefly Spaniards (from the province of Catalonia) and of late years more Italians. They obtain from 40 to 70 bushels to the acre and in the vicinity of Chacabuco (127 miles west of the city of Buenos Aires) 90 bushels to the acre was quite common last year. Rent varies from $1.60 an acre outside, say 70 miles from the river, to $2.25 an acre inside. Most of the land is rented, but small proprietors are fast increasing, hence the manner of cultivating is rapidly increasing. This is shown by the increasing amount of improved machinery and implements sold. I think the fact that a large amount of the corn exported is used for distilling accounts in part for carelessness in shipping.

A general opinion was found to prevail among the better class of "estancieros" that they must grow and feed corn. One man offered extremely liberal terms to secure some North American corn raisers to come down and use some of his land, well suited for corn, to show how the crop should be grown. These men differ from the common farmers, or "colonists;" they are quick to take up new methods when they become convinced that they can make money by doing so. Once

they get started into anything they go into it heavily, as they have into alfalfa. As soon as they fully realize, as some of them now do, that corn is the other thing they need to supplement alfalfa in the production of beef, we shall see them going in for corn, and raising it themselves on their large stock ranches, to finish their cattle. If the English ports are again opened to Argentine live stock, as Argentines hope, it will hasten the development of corn production; for those who are well informed in regard to the cattle trade in England know that the Argentine stockmen can never compete with the corn-fed steers from the United States until they also finish their steers for at least six months on corn. As long as they have only the "frigoríficos" (frozen or chilled meat houses) in Argentina for a market, they will not be in so much haste to begin corn feeding, because for that market, especially for frozen beef, it does not make so much difference. They claim it would not pay to feed corn at present, and it is very seldom done, except for show purposes or some other special reason.

USE OF CORNSTALKS.

Very little use is made of cornstalks in Argentina at present. Usually they are plowed under as soon as possible. Some of the more painstaking farmers gather them into windrows, when dry, and burn them. Scarcely any corn is cut for fodder, nor are cattle turned into the fields after husking to any great extent. Green feed is usually obtained in the pastures all winter. Feeding the stalks, at least in the field, is being looked upon with more favor in the more progressive regions, and in time the corn-harvesting machinery of the United States will be employed in making use of the stalks to the best advantage.

VARIETIES OF CORN GROWN IN ARGENTINA.

Although eight varieties of corn were recognized by the Argentine Rural Society in its catalogue for the agricultural show in May, 1903, only four or perhaps five kinds are recognized commercially. They are here described.

KINDS IMPORTANT IN COMMERCE.

Yellow.—This is the common kind which forms 90 to 95 per cent of the crop and is practically the only kind recognized in European markets. This is a small kerneled, long and slender eared sort, very much the same as our flint corn. The kernels are very hard and smooth, but it is a very heavy, rich, strong grain and it does not absorb moisture as the softer-grained varieties do; hence it stands a long ocean voyage better. It is highly valued for distilling and for fattening. For the latter purpose it is usually partly crushed, as it is so hard that animals do not masticate it readily. The plant is very sturdy and prolific, usually bearing two or three ears.

Yellow corn goes by various names, the most significant being

"Cuarenton" and "Cincuentino," from the Spanish words "cuarenta," meaning forty, and "cincuenta," meaning fifty. The name is applied signifying the number of days required to begin the formation of ears.

Morocho.—This is a white corn, otherwise somewhat similar to the yellow—small, smooth, and flat. It is preferred for horses, as it is said to be strengthening without being fattening. It is not equal to the yellow corn for distilling.

Polenta.—Polenta is a Piedmontese variety, which originally is small and red, with a smooth, flat grain. It is used to make meal for table use, especially for a sort of mush, of which the Italians are very fond, and from this it gets its name, the Spanish word "polenta," meaning corn-meal mush. After a few crops this variety degenerates into ordinary yellow corn and fresh seed must be imported. It is seen in all degrees of purity and its cultivation is increasing.

Pisingallo.—This is a small-kerneled, small-eared, white-flint, chiefly from tropical regions. A very good quality, but little grown.

Criolla.—"Maize criolla," or native corn, is an inferior variety, grown in the northern part of the country, in the provinces of Cordoba, Santa Fe, Corrientes, and Entre Rios. It is yellow, smaller than the other varieties, smooth, and very hard. It is too hard for horses and is of little value for distilling. It yields poorly, has an extraordinary amount of husk and stalk, and ripens slowly. Its chief recommendation is that it is immune from the attacks of locusts, unless they get it in tassel, fresh. It is often sown in case of failure of some other crop, as sometimes happens with corn of other varieties. It is sown as late as the 1st of December and requires sixty days to form ears. The corn brings a poor price in the market and but little of it is offered.

NORTH AMERICAN VARIETIES IN ARGENTINA.

Some of the large North American corn, both white and yellow, commonly called "horse tooth" corn, has been tried in Argentina, but it is not yet popular. They think it is not as strong as the flint varieties they have been raising, and no doubt it will not do as well when crowded as they plant it. It is claimed that our dent corn degenerates in Argentina. But some farmers have a desire to try our varieties and our system, and they will soon get into it. Recent experiments, especially the one by Dr. F. R. Cibils, the well-known Argentine agricultural writer, chief of the Division of Commerce and Industries of the Argentine Department of Agriculture, have shown the adaptability and value of North American varieties in Argentina.

GOVERNMENT EXPERIMENTS ON VARIETIES.

An experiment was made during the season of 1901–2 with twelve varieties of corn, six of them North American, near Pehuajo, 225 miles west of the city of Buenos Aires, on the Western Railway. The results were not as satisfactory as expected, owing, it is said, not so much to

the lack of adaptability of the varieties as to the unfavorable weather of the season. The unusually heavy rains of October and November prevented the plants from getting a good start, and at the end of December they were injured by withering heat. Yet some good results were secured, to be the basis of future experiments. It was demonstrated that the large North American dent corn will give splendid results in Argentina if rightly cultivated in seasons not unfavorable to corn growing.

TABULATED RESULTS.

The seed for this experiment was sent out by the Division of Agronomy of the Argentine Department of Agriculture, after having been carefully tested by that division, which made a report on the seed from which the following information was taken. The country from which the seed was brought, time of planting and of ripening, amount of seed planted and of yield, with other important data, are presented in tabular form for convenience of comparison:

Cultural value, etc., shown by foreign seed corn in Argentina.

YELLOW VARIETIES.

Variety.	Origin of seed.	Purity.	Germinative power.	Cultural value.	Weight of 1,000 kernels.	Weight per hectoliter.	Weight per bushel (Winchester).
		Per ct.	*Per cent.*	*Per cent.*	*Ounces.*	*Kilos.*	*Pounds.*
Queen	North America	99.38	96.50	95.90	10.09	72.10	56.01
Pedrick's Golden	do	99.10	92	91.17	15.97	69.80	54.23
Golden	Italy	98.40	93	91.51	6.19	81.00	62.93
Precious of Auxonne	France	99.12	71.50	70.87	5.47	75.93	59
Canadian Flint	North America	98.10	85.50	83.88	10.31	76.25	59.24
Chester Giant	do	99.20	89.50	88.78	12.67	71.00	55.16
Lombardy	Italy	95.96	60	57.57	16.11	71.47	55.52
King Philip (brown)	France	99	75.50	74.75	10.75	74.87	58.16
WHITE VARIETIES.							
Hickory King	North America	98.80	97.50	96.33	17.55	69.20	53.76
Neapolitan Grand	Italy	98.25	98	96.29	12.86	72.40	56.25
Horse Tooth	France	96.55	68	65.65	13.11	71.93	55.88
White Head	North America	99.40	78	77.53	13.62	69.00	53.60

The following is a summarized statement of the results with the varieties, showing the time of planting and ripening:

Time of ripening, yield, etc., of foreign corn in Argentina.

YELLOW VARIETIES.

Variety.	Time of planting.	Seed planted.	Yield.	Time of ripening.
		Pounds.	*Pounds.*	
Queen	November 1	4.4	418	May.[a]
Pedrick's Golden	do	4.4	330	May.[a]
Golden	End of October	4.4	264	March.
Precious of Auxonne	December 1	4.4	176	April.
Canadian Flint	End of October	2.2	88	March.
Chester Giant	November	2.2	66	May.
Lombardy	End of October	2.2	88	March.
King Philip (brown)	do	4.4	209	May.

[a] Cultivated twice.

Time of ripening, yield, etc., of foreign corn in Argentina—Continued.

WHITE VARIETIES.

Variety.	Time of planting.	Seed planted.	Yield.	Time of ripening.
		Pounds.	*Pounds.*	
Hickory King	November	2.2	165	May.
Horse Tooth	End of October	6.6	176	May.
Neapolitan Grand	November	4.4	110	April.
White Head	End of October	4.4	44	(a)

a Irregular germination.

All except Queen, Pedrick's Golden, and Precious of Auxonne were planted in land that had been used for wheat or linseed, mostly the former. The three exceptions were planted in new land. It is understood the planting was done with a drill, but that the rows were farther apart than is customary in Argentina.

OBSERVATIONS OF FARMER IN CHARGE OF WORK.

The comments of the man in charge of the experiment, who was a practical farmer, are given in substance as follows, touching each variety:

Queen.—Yellow dent. Very productive and suitable to locality. Imperfect grains and incomplete development of ends of ears, but would secure better results by earlier planting, without such heavy rains during first two months of growth. Excellent for distilling, feeding, and meal.

Pedrick's Golden.—Yellow dent. Productive. Grains well developed. Defective ears attributed to unfavorable weather in spring and at time of fertilization. Will do better.

Golden.—Yellow flint. Noted for its resistance to drought. Planted in November and December and matured in three months, with well-developed ears, even at the ends, notwithstanding the weather. Specially good for meal and for porridge.

Precious of Auxonne.—Yellow flint. Quick growing, three months' corn. Ears not so well formed and smaller yield; attacked by fungus. Used mostly for bread and porridge.

Canadian Flint.—Under favorable conditions will mature in less than ninety days, giving long ears of good grains, well formed and even. This variety is said to be well suited to the Argentine market, and to be excellent for bread and "polenta," or corn-meal porridge. In the present experiment the ears were badly formed and were attacked by insects. The variety is well known in the country, and has done well in many localities.

Chester Giant.—Yellow dent. Very luxuriant plants, suitable for green fodder, but badly developed ears, showing degeneration. Will do best in sandy soil. Best for fattening and distilling.

Lombardy.—Yellow flint. Excellent quality, much appreciated for the quality of flour it makes for bread and "polenta." In this case

the ears were few and not well developed, owing to the dry, hot weather at the time of fertilization.

King Philip.—Brown, or wine-colored, flint. Long, slender ears, and under ordinary conditions quite productive. It is well suited to some parts of the country, and has been grown successfully in the Provinces of Entre Rios, Santa Fe, and Cordoba. Its color seems to be against it in the market, though it makes good feed for animals and is valuable for distilling.

Hickory King.—White dent. Best of all white varieties known to experimenter. Well suited to temperate climate, though it has done well in Cordoba and even as far north as Bella Vista, in the Province of Corrientes, nearly 600 miles north of Buenos Aires. The ear is large, but badly formed and undeveloped at the top and bottom. It was not planted early enough to get a good start, and so did not have sufficient rain in its early growth; the heat and drought retarded its development and fructification.

Horse Tooth.—White dent. Good for all purposes for which corn is used, but in this case the result was not good. There was a very small yield of inferior ears, with badly deformed grains. It should have been planted earlier.

Neapolitan Grand.—White flint. Especially desirable for making bread, and hence useful in Argentina. This result was bad; it should have been planted earlier.

White Head.—Seed lacked strength and gave bad results, no grains being fit for seed. The ears were uniform, but the grains were deformed and degenerate. It is not of much importance.

GENERAL RECOMMENDATIONS.

Pedrick's Golden and Golden are recommended as the best of the yellow varieties, and Golden is especially recommended because dent corn is little appreciated in the Argentine markets at the present time. Commenting on this situation, the chief of the Division, Carlos D. Girola, says:

> It will be an error to abandon the cultivation of the dent corn, to which the farmers of North America are so devoted and with which they have been so successful. We do not understand why the exporters of corn in this country refuse the dent corn, when such a large proportion of the production and exportation of North America is of these varieties, which have been found so useful for distilling, for feeding cattle, and for making flour. We should now cultivate these varieties for our own consumption, for feeding animals, and for making flour. There is no doubt that this corn will be extensively cultivated in the future when it becomes better known and appreciated, and that it will be more favorably looked upon in the markets. When we have distilleries it will find ample use.

Farmers are urged to improve their methods, to plant the rows farther apart, and to cultivate the corn with more care. They are assured that by doing this they will be getting larger returns for their labor than in almost any other way. "It is a great error," this writer

says, "to suppose that by planting close together a larger crop may be had or the ground kept moist during dry weather."

Speaking of the varieties and quality of corn exported from Argentina, Director Tidblom, of the Division of Agriculture and Animal Industry in Argentina, says:

> European buyers of maize have, in ordinary years, a fancy for small-grained maize (corn) and are not sufficiently influenced in favor of really fine quality to pay an extra price to shippers. Therefore the shippers think mostly of the condition and safety for the voyage. If they can get the cargoes home in good order for immediate use, and of average color and plumpness, they are satisfied.

CORN IN THE NATIONAL AGRICULTURAL SHOW.

The agricultural exposition given by the National Rural Society in Buenos Aires in May, 1903, was the first of its kind ever given in Argentina. Live-stock shows on a large scale have been highly successful for the past eight years, but agriculture has received but little attention. This first attempt at a national agricultural exposition was made in connection with the annual fat stock and horse show. It brought together some excellent collections of grains and other agricultural products.

Many samples of various varieties of corn were shown, usually as ear corn. The area from which the corn exhibits came extends north from Tandil, in latitude 37° south, 205 miles by rail south of Buenos Aires—or about the same as Richmond, Va., Wichita, Kans., or San Francisco—to latitude 25° south, including the remote northwestern province of Jujuy and the northeastern territory of Misiones. These latter are nearer the equator than the most southerly point of Florida or Texas.

From Tandil, which is a somewhat higher, cooler locality than the country farther west in the same latitude, came some Morocho corn, a white flint variety, that weighed 63.43 pounds per bushel of shelled corn (81.5 kilos to the hectoliter).[a] This was considered very good, as corn from the south had heretofore been light. From the Province of Entre Rios, on the Uruguay River, yellow cuarenton corn was sent that gave 64.49 pounds per bushel on new land. Some yellow flint was brought from Casares, 191 miles southwest of the city of Buenos Aires, that gave 65.2 pounds to the bushel. From Francisco Madero, on the same line 43 miles farther west, some Polenta corn was exhibited that weighed 65.9 pounds to the bushel. Specimens of Morocho were brought from southern Cordoba and from places not far from Buenos

[a] The quality of corn and wheat is judged in Argentine largely by its weight in kilos per hectoliter. The equivalents in weights per bushel are here given for convenience of comparison with American corn, which weighs 56 pounds per bushel of shelled corn.

Aires that gave 64.49 pounds to the bushel. Corn above this weight is considered remarkable. Well-formed ears were shown 11.8 to 12.6 inches long.

CORN FROM TROPICAL REGIONS.

Some corn from the Territory of Misiones, raised in about latitude 26° to 27° south, more than 200 miles nearer the equator than New Orleans and 150 to 200 miles nearer than Galveston, Tex., caused some surprise. It was of a fair quality, not first-class, but good when the methods of cultivation are considered. The soil is a rich red, hardly ever, it is said, less than 3 feet deep, in many places more, and sometimes as much as 30 feet deep. The richness of this soil may be imagined, says the Rural Society's official report of the exposition, when it is known that the method of planting is to throw the seed on the ground without plowing, and then to scratch the soil a little with a pointed stick. This territory, the extreme northeastern part of Argentina, is one of the oldest, richest naturally, and yet least developed and most backward sections of the country. Its only means of transportation to market is the Upper Parana River, so the corn they raise is at present only for local use—to feed a few pigs and chickens. If with these primitive methods, without culture, corn of fair quality can be produced, what might be done on this land if corn was properly planted and cultivated, asks the writer of this report. In some places this land has been giving corn crops continually for eighteen years, and producing ears nearly a foot long. If the manufacture of alcohol is undertaken, utilizing some of the great water power in that part of the country, the growing of corn will, it is said. be greatly stimulated and will be more profitable.

The Province of Jujuy, in the other extreme of the tropical part of the country, sent some of the small Pisingallo corn and also some excellent samples of the larger white-flint corn, Morocho.

A PROSPECTIVE CORN REGION.

It is predicted that the great Territory of the Pampa, southwest of Buenos Aires, which is already giving such good alfalfa, potatoes, and wheat, will soon be yielding good crops of corn in certain sections. Sir Thomas Holdich, the English engineer who settled the boundary dispute between Argentina and Chile, referred to the Pampa as "the granary of the world," he was so impressed by its possibilities.

NORTH AMERICAN KINDS EXHIBITED.

Some samples of North American varieties shown by Dr. F. R. Cibils, chief of the Division of Commerce and Industries of the Argentine Department of Agriculture, prove that the Argentine soil and

climate are well adapted to the production of these varieties. One was a cross of Ohio Flint and Golden corn, producing a perfectly formed, thick, heavy ear, with kernels tightly set, fat, ripe, and hard. This crossed on White Mammoth, "the favorite dent," produced a longer ear, almost white, not quite as well developed at the tip, but still an excellent corn. Chester Mammoth Dent, yellow, gave the largest ears, about 12 inches long, but not so well formed nor as firm, and mixed with white kernels. Yellow Flint of Ohio turned out most satisfactorily, giving long, straight, uniform ears, with thick, heavy kernels closely set and developed to the very tip.

ADVICE TO FARMERS.

The conclusions of the author of the Rural Society's study of this exposition is that to the southwest of Buenos Aires and in the southern part of the Province of Cordoba are now the best corn fields.

Farmers are strongly advised to raise more corn and to raise hogs to eat it, as the most economical production of good pork requires corn feeding. On stock ranches, it is said, every pig that is raised along with corn-fed cattle is as good as each cow giving another calf, and it doubles the value of the corn harvest. The loss of the Brazilian market for Argentine pork products is attributed to feeding pigs on refuse and the consequent low quality of pork sent to market. Even now, the report says, very inferior products are consumed in Buenos Aires when the imported article is not to be had. Argentines are urged to produce more and better pork and to do it with corn. It is even claimed that two crops of corn might be grown in a year, the climate is so favorable.

THE EXPORTATION OF CORN.

SHIPPING FACILITIES AND PROPOSED IMPROVEMENTS.

The facilities for handling grain in Argentina are inadequate, causing delays and losses, and increasing the burden which the producer must bear in getting his crop to market. Shippers must nearly always wait some days to obtain cars, which are distributed by towns, and the railway companies generally require shippers to state what ship the consignments are intended for before cars will be given them in the country stations to load for the seaports, Buenos Aires, Rosario, Bahia Blanca, or La Plata, especially the first named. The docks are so crowded during the busy seasons that the railway companies try to provide cars first for those who have ships ready to load, preventing speculators from cornering the market and filling the yards with grain in order to compel shippers who have ships waiting to pay them an exorbitant price for the grain they must have.

FREIGHT CARS AND CHARGES.

The cars are now being made larger and several of the principal lines have many 35 and some 40 ton cars; but there are still very many 10 and 15 ton English cars in use. Nearly all the railways are owned and, except for minor positions, operated by Englishmen. The railway companies allow three days for unloading cars, for which no extra charge is made; after that, $1.70 per day. The port of Buenos Aires allows six days free use of its yards for cars unloading; after that there is a yardage charge of 85 cents per axle, the cars having, according to their capacity, from two to four axles. No switching charge is made. Weighing is 12 cents per ton and loading on ship-board costs about 18 cents per ton.

PORTS OF BUENOS AIRES AND BAHIA BLANCA.

The port of Buenos Aires is so crowded that during the busy seasons ships are very often obliged to lie two or three deep alongside and carry loads across each other's decks. This is the more easily done because grain is always in bags, and if shipped in bulk is carried across to the ship in bags and the bags cut open on board. Sailing vessels are not allowed to have berths alongside when any steamer wants a berth. Very extensive improvements are in process of construction by the Great Southern Railway Company in Buenos Aires and Bahia Blanca, which will more than double the capacity of the present docks and moles, the latter being the form of structure at present in use at Bahia Blanca. The latter is a great natural ocean port. Its immense advantage over Buenos Aires, which is only at best a shallow river port, at the mouth of the River Plate, will make Bahia Blanca, with the rich and fast-developing country around it, the future great port of Argentina. The port of Buenos Aires must be constantly protected by dredging and is always liable to have low water, so that ships drawing more than 22 or 23 feet of water are not sure of being able to get out. The river is constantly building new bars and banks and adding to the land with the heavy silt which it carries. In June, 1903, a large European mail steamer was detained four days in the port of Buenos Aires because there was not water enough to get out. The Federal Government has improvements and extensions to the port of Buenos Aires under consideration, planned by Dr. E. L. Corthell, the distinguished American engineer, who was employed by the Government for two years to plan port works and river improvements. These improvements will be commenced in a year or so, when the necessary $10,000,000 can be secured, and will then afford ample room for all business. The present docks are built of granite, and are first class as far as they go.

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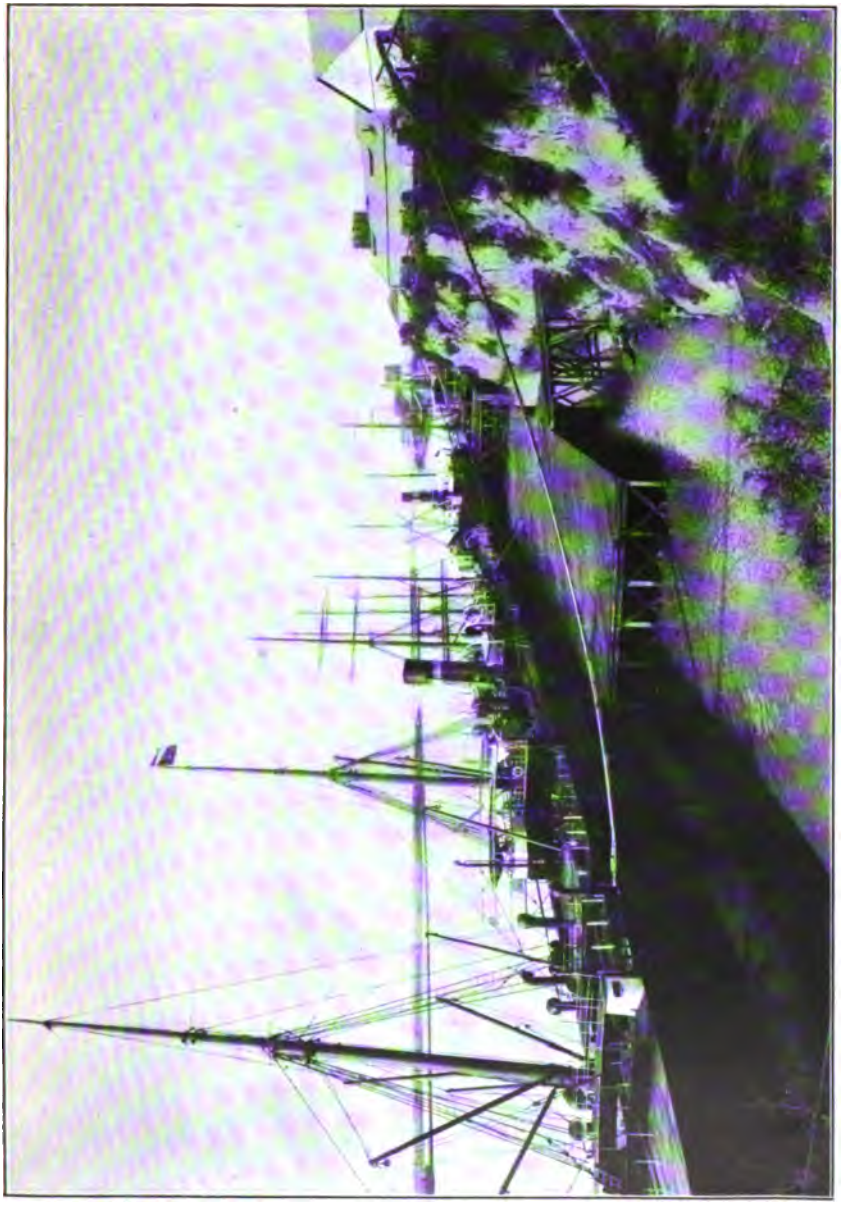
RIVER PORTS.

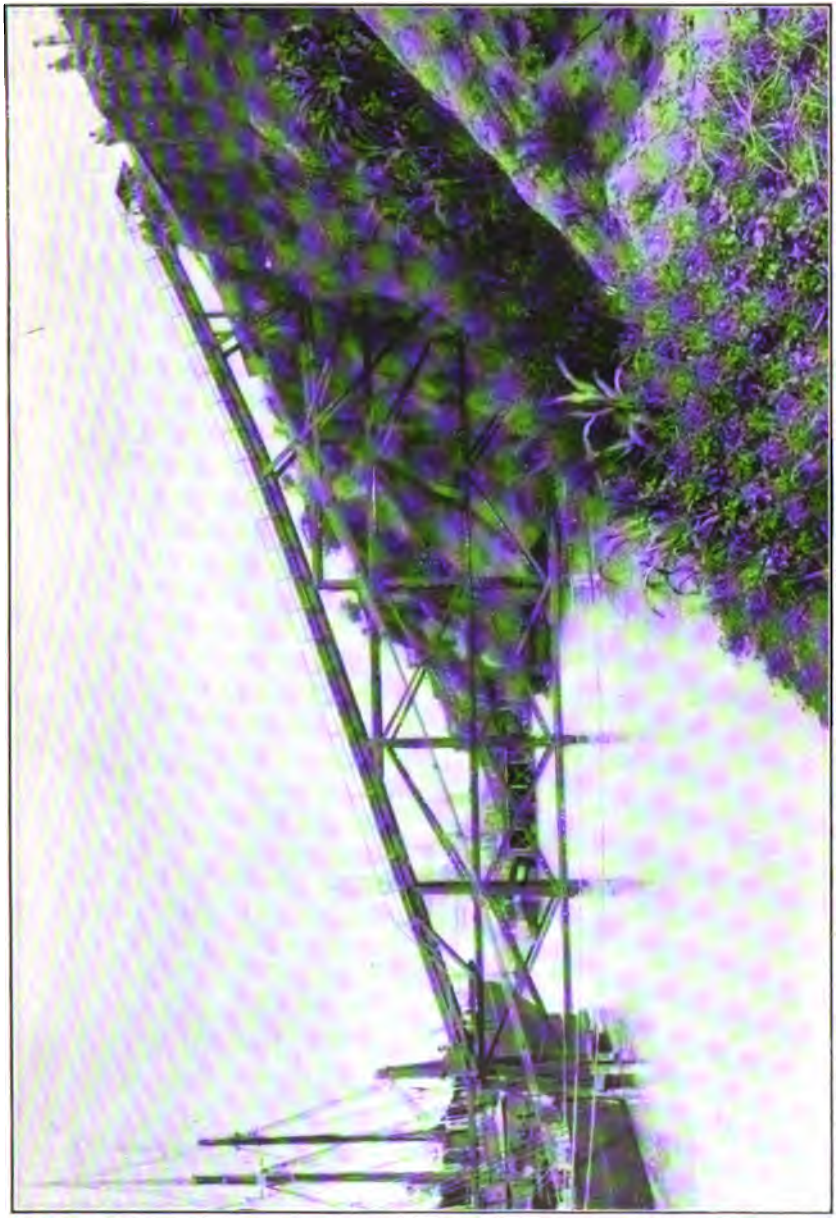
The greatest shipping point, next to Buenos Aires, at present, is Rosario (Pl. V, fig. 2), 188 miles by rail and much farther by water from Buenos Aires. Ships drawing 24 feet of water can load at Rosario by simply lying out in the stream and receiving their cargoes by means of long chutes called "canaletas" (Pl. VI) from warehouses on the high banks. Nothing more is required. The Government, however, has provided for the building of docks there that were planned by Dr. Corthell and will cost about $10,000,000 gold. The work has been undertaken by a company that is to have the working of the docks and the custom-house there for a long term of years to pay for the docks. The Government does not put a dollar into it, except agreeing to keep the river channel between Rosario and Buenos Aires open for ships drawing 24 feet. At present ships can not safely load more than 18 feet in Rosario, because if they do they are liable to be detained for days on the bar at Martin Garcia, near the mouth of the river, above Buenos Aires. So the larger ships must take part of their loads in Rosario and go to Buenos Aires to complete, and on going in must leave part of their cargoes in Buenos Aires before proceeding to Rosario. The concessionaries have been for some months in possession of the port of Rosario, and are preparing to enforce their monopoly and stop all the cheap loading with chutes. (See Pl. VII.) They are now collecting all port dues, which have been somewhat increased. Many shippers expect to remove their business to other ports because of the increased charges that must necessarily be put on to pay dividends on the costly improvements now in prospect. The Parana River, on which Rosario is located, offers many natural ports for many miles along its high banks, and these are being improved to some extent and made ready to compete with Rosario. Grain men think they can pay freight to any of these small ports and load there cheaper than they can patronize the new port.

LACK OF ELEVATORS AND WAREHOUSES.

No conveniences for loading grain are provided in the country stations. There are no elevators and few warehouses, the latter almost invariably owned by private parties, usually buyers for their own use. There is no public storage for hire, to amount to anything, and if there was the farmers could not be persuaded to pay anything for the use of it. They are very much averse to paying out a single cent that can be avoided; they have not been educated up to the point of spending 10 cents to save $2, and they follow the practice of losing the $2 nearly every time. Grain is generally piled up in bags in the station yards, if cars are not ready, and it often suffers damage. Some of the railway companies, especially the Great Southern, have erected sheds for grain. The Argentine Congress has just passed a law requiring all



LOADING GRAIN WITH PORTABLE "CANALETAS" AT ROSARIO.



LOADING GRAIN DOWN A PERMANENT CANALETA, OR CHUTE, AT ROSARIO.

railway companies to provide free shelter for grain offered for shipment. The law went into effect on September 17, 1903, and allows the railway companies eight months in which to build sheds in all stations in the agricultural regions, as directed by the Department of Public Works. At the end of this time the railways will be liable for heavy penalties for failure to provide sheds, and are liable for all damages to grain offered for shipment that is due to lack of sheds. The railways are prohibited from making any charges for storing grain offered for shipment. This law is the outgrowth of the shortage of cars for handling the rapidly increasing grain business, and is intended to force the railway companies to handle the traffic more promptly. Elevators are now being considered and will be built within a few years, as soon as mixed farming becomes more settled and it is possible to say with more certainty what a section of the country will produce to give business for an elevator for any number of years together. Immense elevators are now being built in Buenos Aires and Bahia Blanca. There are several in Rosario, but they have not been in general use for several years. It is claimed the charges were prohibitive. One of them has been used by a corn-shipping firm for cleaning and drying corn, and with excellent results.

METHODS OF LOADING AND SHIPPING.

HANDLING AT PORT OF SHIPMENT.

Corn is usually exported from Argentina in bags of about 155 pounds weight. A year ago it was estimated that 90 per cent of the exportation was in bags and only 10 per cent in bulk. The proportion of bulk shipment is now somewhat greater. Sometimes cargoes contain both bagged and loose corn. In case of separate parcels in a ship belonging to different shippers, the bags are marked and piled separately.

In Buenos Aires and La Plata bags are either carried on board by men or swung on from cars alongside the docks by hydraulic cranes or steam winches. Corn to be shipped in bulk is always carried on board in bags and the bags cut open and emptied into the hold.

In Rosario several means are employed, chiefly the "canaletas," which are long, wooden chutes made in sections and swung on cables from the elevator or warehouse on the high bank to the ship lying in the stream below, as shown in the illustration (Pl. VI). In some cases grain has been loaded in bulk by the same system, with spouts. In another part of the port, where there are no high banks, the hydraulic crane and steam winches are used (Pl. V, fig. 2). In the smaller ports on the Parana and Uruguay rivers the "canaletas" are used.

At Bahia Blanca grain is loaded by steam winches from the cars, by men carrying the bags on board, and by a system of endless chains, carrying the bags a distance of about 100 feet from the cars to the ship's side, where they are slid into the hold. For handling in the dock

the charge is 35 cents gold, per metric ton of 2,204.6 pounds. For handling from the deck, either putting bags in the hold or cutting bags open and allowing the contents to fall into the hold, the charge is 16 cents gold, per ton. The commercial seaport of Bahia Blanca is 4.35 miles from the city. The railway company charges 65 cents gold, per ton for switching cars from the city yards to the shipping port. Another railway company has a mole also, and the switching charge between this mole and the city, 9.31 miles, over two railways, is $1.36 gold, per ton. The endless chains, working on two ships at a time, loading into all hatches, expect to load 1,500 tons of grain per day into a ship. It is a very dusty place, full of fine sand, which is very damaging to exposed machinery like this. The facilities are greatly inadequate, but extensive improvements now under way include huge elevators, large docks in addition to the present steel mole, and modern equipment for loading in bulk. The whole system is owned by the Great Southern Railway Company, the principal railway of South America, which controls transportation in the best part of Argentina, and is giving serious consideration to the construction of grain elevators and warehouses. Some lightering is done at Bahia Blanca when the mole is crowded and ships are waiting. The lighters are of 350 tons burden and the charge is 30 cents per ton. The bags are lifted from the lighters by steam winches on board the ships. Portable elevators are never used.

OCEAN TRANSPORTATION AND CHARGES.

Corn exported from Argentina to Europe and England is generally carried in tramp steamers of from 2,500 to 6,000 tons burden, that require about thirty-five days for the voyage. Some shipments are made in liners or mail steamers, requiring only twenty-one to twenty-four days for the voyage. A very small amount goes in sailers, which require seventy to one hundred days to go to Europe, quite too long for grain shipments. Liners are preferred on account of their quick service, and they often take corn at low rates for ballast when the freight market is dull. Sailing vessels take corn to South Africa because, owing to favorable winds, they are able to make the voyage from the River Plate in twenty-five to twenty-eight days. Steamers do it in fifteen to eighteen days—usually fifteen.

The condition of the freight market constantly varies. Crop conditions, the wool market, favorable weather for handling corn, the demand for tonnage to Brazil and South Africa, as well as to the River Plate countries—all these things and other influences affect the supply, character, and price of tonnage from Argentine ports to Europe.

Liners bring general cargoes from Europe and carry back grain, hay, frozen or chilled meat, and other produce. They can not wait for cargoes, hence sometimes make liberal offers for business. Tramp steamers do a great variety of things, as the season and conditions

suit them. If they are assured in advance of a profitable return cargo they will come out from Europe in ballast, when the demand for tonnage for other parts of the world permits them to do so. Frequently they bring coal, and sometimes general or special cargoes. Often they bring cargoes to Brazil and go to the River Plate, 1,100 miles, or five days' voyage, in ballast. Recently quite a number have been going to South Africa loaded and crossing to Argentina in ballast. Sailers go in ballast to some United States or Canadian port and load lumber for Argentina.

CARE IN TRANSIT.

Sometimes temporary wooden bulkheads are put in front of the engine room, leaving an air chamber a foot wide, which is kept full of fresh air to prevent heating the corn. But this is an unusual precaution, not the rule. Indeed, it is claimed that the corn next to the bulkheads, where there is most heat, often comes out the best. Occasionally a ship will be lined with straw matting or matting made of the tall rushes that grow in the Parana River, but this also is the exception, especially as most of the corn is bagged.

RAILWAY FREIGHTS.

Freight rates in Argentina are high, compared with the United States. The railways, being nearly all English and owned by the same group of capitalists, have long and very favorable concessions from the Federal Government, under the supervision of which they all are.

The rates on corn on one of the principal lines were as follows in 1902:

Freight rates by rail in Argentina.

Number of miles.	Rate per bushel in United States cents.	Number of bushels carried for 41 cents, at bushel rate.
25	2.74	14.96
50	3.92	10.45
100	6.10	6.72
200	8.92	4.59
300	11.03	3.71
400	12.99	3.15
500	14.38	2.85
600	15.76	2.60
700	17.13	2.39
800	18.50	2.21
900	19.87	2.06

These rates are a trifle higher than those in force on some other lines traversing corn regions. Rates on Argentine railways are quoted in Argentine gold per 1,000 kilos (2,204 pounds), and are divisible in fractions of 10 kilos. Very little corn in Argentina is shipped more than 200 miles by railway, and most of it less than 100 miles.

Freight rates on corn in the United States in 1900, according to statistics published by this Department, were as follows, in cents per bushel:

Chicago to Buffalo by lakes, 1.71.
Buffalo to New York by canal and river, 2.31.
Chicago to New York by lakes, canal, and river, 4.02.
Chicago to New York by lake and rail, 6.44.
Chicago to New York, all rail, 9.19.
Atchison, St. Joseph, Kansas City, or Leavenworth to Chicago, 16 cents per 100 pounds, or 8.96 cents per bushel.
Atchison, St. Joseph, Kansas City, or Leavenworth to St. Louis, 11 cents per 100 pounds, or 6.16 cents per bushel.
St. Louis to New Orleans by river (in sacks), 10 cents per 100 pounds, or 5.6 cents per pushel.
Rates at present in force from Iowa points to Chicago are 17 cents per 100 pounds, or 9.52 cents per bushel, in carload lots.

OCEAN FREIGHT RATES.

Ocean freight rates on corn from River Plate ports vary considerably according to the condition of the freight market. Now the range is from 8 to 20 shillings per shipping ton of 2,200 pounds. The charter rate from Buenos Aires, in good tramp steamers, is at present about 13 to 17 shillings per ton. From upriver points, such as Rosario or San Lorenzo, the rate is usually one shilling sixpence to three shillings higher because steamers may not always load to their limit there, but must stop at Buenos Aires to finish. They can not get across the bars on the way down with a full load drawing more than 18 feet, except at unusual stages of the river.

Rates in shillings per shipping ton of 2,200 pounds converted into cents per bushel, United States money, are as follows:

8s. per ton equals	4.95c. per bu.	16s. per ton equals	9.91c. per bu.
10s. per ton equals	6.19c. per bu.	17s. per ton equals	10.53c. per bu.
12s. per ton equals	7.43c. per bu.	18s. per ton equals	11.15c. per bu.
14s. per ton equals	8.67c. per bu.	20s. per ton equals	12.38c. per bu.
15s. per ton equals	9.29c. per bu.		

The range of ocean freight rates on corn from New York and Boston to European ports during May, 1903, was as follows, in cents per bushel:

Ocean freights on corn from United States to Europe.

To—	From New York.	From Boston.
Liverpool	3.04	3.04
London	2.02 to 3.54	4.05
Glasgow	3.04	3.04 to 4.05
Hull	5.57	6.08
Hamburg	4.76 to 5.23	5.06 to 6.08
Rotterdam	3.00	5.06
Marseille	6.08	.....
Copenhagen	8.11 to 9.12	8.11
Havre	9.12	.....
Genoa	.....	4.56 to 5.06

EXTENT OF EXPORTS OF CORN FROM ARGENTINA.

Argentine exportation of corn from 1886 to 1902, inclusive, has been as follows, in bushels, with the valuation in United States money:

Total exports of corn from Argentina, 1886 to 1902.

Calendar years.	Quantity.	Value.	Calendar years.	Quantity.	Value.
	Bushels.			*Bushels.*	
1886	9,119,970	$4,490,551	1895	30,404,504	$9,836,571
1887	14,245,035	6,983,595	1896	61,827,888	15,434,756
1888	6,389,699	5,253,908	1897	14,760,664	5,286,963
1889	17,030,168	12,523,501	1898	28,230,887	8,949,600
1890	27,844,175	13,650,542	1899	43,945,394	12,586,479
1891	2,594,692	1,335,645	1900	28,079,045	11,516,066
1892	17,555,605	8,261,588	1901	43,788,911	18,226,338
1893	3,327,135	1,523,296	1902	46,959,122	22,189,268
1894	2,160,370	1,009,397	1903 (estimated Nov. 5)	78,750,000	31,500,000

The distribution of Argentine corn exports for 1902 to the several countries of destination is shown in the following table:

Countries importing Argentine corn in 1902.

Destination.	Bushels.	Destination.	Bushels.
United Kingdom	11,658,515	Spain	305,731
Germany	4,738,985	Brazil	74,445
Belgium	4,252,870	Other destinations[a]	4,166,497
France	2,046,066	For orders[b]	18,759,099
Italy	956,914		

[a] Including all other European countries and South Africa.
[b] Cargoes going to St. Vincent to receive orders to proceed to some European or English port, where the cargo has been placed during the voyage from the River Plate to St. Vincent.

INSPECTION.

LACK OF GOVERNMENT INSPECTION.

There is no Government inspection of corn in Argentina, for export or for any other purpose. The Argentine Department of Agriculture has studied the subject, and shippers, shipowners, and grain associations have been consulted, but nothing has come of it beyond the resolve to create a commission to look into the matter when the funds for such purpose can be spared. Grain exporters have not taken kindly to the idea. They do not want any Government interference with their business. Those who are taking the necessary precautions and shipping nothing but grain they know will go through without loss do not require any inspection. Those who are in a speculative trade, taking chances on buying poor grain at a low price, hoping to make a large profit if it arrives in fair condition, do not want the Government to injure their business by inspecting and grading this corn for what it appears to be before exportation. Often they lose heavily on these speculative cargoes, but the profit is so great if they succeed in getting them across without further damage that they will take long

risks. Cargoes arriving in bad condition often recover and are sold at better prices than the arbitration allowances. It is quite difficult, as the Argentine Government officials have found, to get the results of experience that has cost shippers thousands of dollars to acquire. They prefer to go on quietly making use of it themselves, leaving others to learn in the same way they did. But during a year's time the writer found many opportunities to learn and observe the methods employed by the most successful and conservative shippers of corn from Argentine ports to England and the Continent. They were quite willing to answer questions, and were kind enough to afford means for personal inspection of the details of their shipping arrangements.

PRIVATE INSPECTION.

The only grain-inspection system in Argentina that is accepted in Europe and England is that established and conducted by an Englishman who served formerly as the English Government inspector of hay, bran, etc., bought in Argentina for the army in South Africa. This gentleman inspects all kinds of grain and hay for foreign buyers, and owing to his long experience in Europe, the United States, Australia, and Argentina, and to his conservative and thorough policy, his certificates are accepted, and cargoes passed by him have so far arrived in good condition. Offices are maintained in the principal ports of export, and inspectors are sent to other ports and to inland stations to receive grain and hay. Another inspection is made of grain and hay received in country stations before it is loaded on shipboard, because of the danger of damage, especially to hay, en route from the country stations to the seaboard. The prices charged for corn inspection range from 1 to 3 cents per bushel, according to the port or place of inspection and the amount of work required. When this system is not employed grain is sold from Argentina to Europe on "rye" or "tale quale" terms.

GRADING CORN FOR EXPORT.

There is little grading of corn in Argentina for export, except such as is done by individuals. Corn that is suitable for export is known as "export type," being generally the small-grained, hard yellow or white, and dry and sound. Beyond these general requirements there is no common standard in the Argentine markets. Every buyer fixes his own standard according to his own ideas to fit the market in which he expects to sell. Corn is usually shipped under the denomination, "fair average quality at time and place of shipment, shipped in good order and condition." If the grain is exceptionally good, it is designated as "prime quality." In all cases it must be sound, clean, and dry enough, in the opinion of the inspector, to stand the voyage and arrive at destination in good order.

In the local markets there are three regular grades of the two principal kinds of corn known to commerce. Both "Maize Morocho," or white corn, and "Maize Amarillo," or yellow corn, are graded as follows: (1) Good to superior; (2) inferior to ordinary; (3) exportation type.

PRICES.

The white corn has usually brought a trifle better price than the yellow, but more of it is now being produced than formerly and the price is about the same. The range of prices is not very wide. Corn is always sold by the 100 kilos, equal to 220 pounds avoirdupois. A sample quotation will show how the prices ranged, though at present there is not the difference in the prices of yellow and white corn. The quotations given here were in force in May, 1902.

Prices of corn in Argentina in 1902.

Kind of corn.	Price per 100 kilos in Argentine paper money.			Price per bushel in United States money.		
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.
White:						
Good to superior	$5.80	$6.30	$6.00	$0.64	$0.70	$0.67
Inferior to ordinary	5.00	5.80	5.50	.55	.64	.61
Exportation type	5.35	5.70	5.50	.59	.63	.61
Yellow:						
Good to superior	5.20	6.00	5.50	.58	.67	.61
Inferior to ordinary	4.40	5.50	5.00	.49	.61	.55
Exportation type	5.35	5.40	5.35	.59	.60	.59

These quotations range from 49 to 70 cents per bushel in United States money, the export yellow selling for about 59 cents per bushel. At this time corn was selling in Chicago for 57.3 cents per bushel and in New York for 63.3 cents per bushel.

In July, 1903, the prices in Argentina for the best export corn were around $4 Argentine paper per 100 kilos, or equal to about 44 cents per bushel in United States money. This is about 10 per cent lower than the prices at the same time in 1902. The prices in Buenos Aires November 7, 1903, were from 31 to 40 cents per bushel, or 40 to 41 cents for the best export type, about 20 per cent lower than on the same date in 1900.

The average prices for corn in the Buenos Aires market for six years ending with 1901 is given officially by the Argentine Department of Agriculture as follows, in cents per bushel, United States money:

	Cents.		Cents.		Cents.
1896	24.55	1898	34.31	1900	37.23
1897	44.44	1899	30.42	1901	48.62

The prices for 1902 were not available, but the average was not far from that of 1901.

IMPORTANCE OF DRYNESS IN CORN FOR EXPORT.

The chief care of the shipper of corn from Argentina is to secure dryness, and that vital quality is harder to obtain than any other. It is not too much to say that three-fourths of the losses on Argentine corn going to Europe have been due to the dampness of the grain before it left the River Plate. The shipper has a constant fight to avoid receiving corn that is full of moisture; to keep it dry after he has received it; to get it on board ship in the same condition; and then to get the ship out of the River Plate before the cargo has absorbed much of the humidity that prevails there during the greater part of the shipping season. If the ship in which corn is loaded gets away within fifteen or twenty days after she begins to load, and the loading has been done with dry grain in dry weather, and the hatches of the ship are securely battened down and, as nearly as possible, hermetically sealed during the entire voyage, the general opinion among the most successful shippers now is that there is practically no danger of damage to the cargo during the voyage. They have largely abandoned the ventilation theory.

CONDITIONS UNFAVORABLE TO DRYNESS AND CLEANNESS.

But many difficulties arise to prevent sending away corn under these favorable conditions. First, there is the faulty cultivation and harvesting, already referred to. Owing to these causes corn is slower to ripen and dry in the field than it should be and the inability of the farmers to get help for the gathering prevents them from husking their corn before the rains of June, July, and August have soaked it. The exception to this is the early corn that is gathered and marketed too soon. A comparatively dry winter is of great advantage to all who are interested in corn, but it is the exception. Of course there is no snow.

Shippers of corn usually send inspectors to the country stations to examine the quality of grain offered. This is done with a long tube, or spear, the same kind that is used for testing wheat. It is thrust into the bag, bringing out a section of the contents and showing its quality all the way through. This testing is done as the bags are being carried from the pile to the railway car, and it may be done again in the port. It requires considerable exertion and the sense of touch of the inspector is likely to become dulled after a time, especially if the condition of the corn varies much and a large proportion has to be rejected for dampness. Inspection is also often made in the "troja," or crib, before the corn is shelled, as the dryness of the cobs plays a very important factor in the dryness of the grain after shelling and it is easier to make sure about it in advance. The cobs being dry and shelling being done in dry weather, the maximum of security is obtained; but dry weather is not always to be had when machines are available.

Every effort is made to get the corn on board ship as soon as possible after it is shelled, but the country roads are generally bad at this season of the year, there is difficulty in getting cars, and often delay occurs in the port while the ship waits for her berth to load. All this time the corn is absorbing moisture more or less. A few shippers have tried to minimize the bad effects of this system by cleaning and drying the corn to some extent before shipping. The shelling machines in use remove the dirt very well, unless the corn is wet when shelled; but a great amount of "fluff," or chaff, is left with it, and this helps to create heat on board ship. Aside from this, Argentine corn comes to market fairly clean and not many complaints are heard on this score. Still, it is generally agreed among those who are well informed that it would be very much better if corn could be put through a cleaner or elevator for the removal of dirt, dust, and chaff that comes out easily within a few days after shelling.

CLEANING CORN BEFORE SHIPMENT.

In Rosario two leading grain houses clean corn before shipping, chiefly to take out the "fluff," which they say contributes very much to the chance of heating on the voyage. One firm has leased an elevator at a low rental and uses no heat. They get an astonishing amount of chaff and small pieces of cob out of the corn—almost enough to furnish fuel for the engine that runs the elevator. This is one of the most conservative English firms, and is very careful not to buy corn on which there is a risk. They shipped many thousands of tons last year and not a single cargo went wrong.

Another house that does a very large business has put in an apparatus to dry as well as clean the corn. It is heated by hot air, and then passed through dry, cool air to take out the heat. But this is not altogether a success, because a certain amount of heat remains in the grain as it goes on board. It would not pay either of these firms to put corn through elevators at the current charges, they say, and no others do it. There is no kiln-drying. The cost of fuel would prevent it, if nothing else did.

UNCERTAINTIES IN THE TRADE.

The most perplexing uncertainty exists in regard to the shipment of corn. It may appear to be dry, and yet not be. Sometimes when it is not it stands the voyage with but little harm. Heating and fermentation are produced by different causes and may be chargeable to qualities of the grain or to surrounding conditions. The line is not always honestly or intelligently drawn between harmless sweating and injurious fermentation. Complaints are made of the decisions of the arbitrators in Europe and England, that they have not so distinguished, and that cargoes have been sacrificed at much greater loss

than the true conditions warranted. It has been suggested that arbitrators should be supplied with samples, and should establish a standard distinguishing between corn that is really damaged and that which has only been discolored by the heating of the oil in the grain without damage to the starch therein. Isolated bags of bad corn may get in among many which are in good condition and cause great damage in spots. The imperfect formation of starch in corn in backward seasons, which can only be determined by chemical analysis, is another cause contributing to fermentation on the voyage. All these conditions have increased the reluctance of the Argentine Department of Agriculture to undertake to inspect and certify to the character of corn or other grain without having a thorough scientific study of the conditions made, with sufficient careful experimentation to remove all doubts.

VENTILATION DURING THE VOYAGE.

Of one thing, however, the officials of the Department who have studied the problem are quite certain—that ventilation of a cargo of corn during the voyage is a very great error. This is the chief point of discussion among those interested in the grain trade, but the great majority of evidence, opinion, and practice is now against ventilation, as far as shipments from Argentina are concerned. Concerning the risks of the voyage, Señor Don Ronaldo Tidblom, chief of the Division of Agriculture and Animal Industry in the Argentine Department of Agriculture, has given me the following statement:

For what is called "ventilation" during the sea voyage it is customary to introduce damp sea air into the ship's hold: and, indeed, if such "reasonable precautions" are omitted, the shipowner is liable to damages for the heating of a cargo; although it is really absurd to think that there is any really effectual ventilation of a mass of grain, unless an elaborate system of pipes be provided for forcing air into every part of the holds: and practically this is impossible with bagged cereals when the spaces between the bags are filled with loose grain for better storage.

The state of the weather during the time of shipment is of great importance; because grain coming from the interior may absorb considerable moisture while waiting in railway cars or lying in the open holds of a steamer for some weeks at various river ports during a spell of damp weather. It is difficult to see how this can be avoided when steamers collect cargo at up-river ports, or wait for cars, because of the intense dampness of many days and of nearly all early mornings during the winter.

The absorption of moisture could be greatly avoided if all cars, on arrival, were discharged into closed warehouses, from which grain could be loaded with great dispatch by means of covered chutes, and the injurious effects of moisture would not have to be feared if the grain were kiln-dried before loading. Unfortunately, these closed warehouses and kilns have yet to be built.

Under the present conditions, after maize has collected moisture, perhaps for weeks, at the seaboard the steamer proceeds to tropical seas, where not only is the action of the sun upon the iron decks very severe, but also the water is hot and the air exceedingly damp. The hatches are removed occasionally and the ventilators are at work day and night pouring in fresh damp air. The idea is that "heated air will escape in the form of injurious gases," but what really happens is that it is

replaced by air containing oxygen, which assists in fermentation, just as fresh air assists in combustion in a furnace. If the holds were closed the air would soon be exhausted of oxygen and the process of fermentation would be correspondingly reduced.

It must also be borne in mind that heat alone will not injure maize and that a moderate amount of heat will evaporate a sufficient amount of moisture from a cargo during the voyage to improve it considerably if there has not been active fermentation. It is remarkable that Argentine maize carried in bunker holds, where it is subjected to moderate heat during the voyage, usually arrives in better order than the rest of the cargo. On the other hand, that part of a cargo which is under the direct action of the ventilating shafts is always in the worst condition. It is, therefore, not surprising that even good maize often fails to stand the ordeal of an extended ocean voyage, more particularly as it is shipped in cold weather and discharged in hot, or vice versa.

A great majority of shippers whose views were obtained and whose practices were observed were opposed to ventilation. There appears to be a modification of the ironclad rule of shipowners requiring ventilation, as stated by Señor Tidblom; since much corn is shipped with strict orders not to open the hatches, which are sealed as tightly as possible. The English firm in Rosario, referred to previously, sends all its cargoes that way.

OPINIONS OF AN EXPERT.

The most thorough study of the question of handling corn that has been made in Argentina was that of Mr. William Goodwin, F. R. G. S., now retired and living in England. He was a little more than two years ago one of the leading grain exporters, and at the same time inspected grain and hay for shipment by others to Europe. He had a very large clientage in Europe and England and his certificates and opinions were received as authority. Having lived for many years in Argentina he had excellent opportunities for observation and study, which he used with good results. Mr. Goodwin has written numerous letters and circulars to the grain trade giving his experience and opinions about the best means of shipping corn to avoid loss by heating on the voyage. He has gone to the root of the trouble—the bad system of cultivation—and in a formal article in the official bulletin of the Argentine Department of Agriculture he gives much good advice to corn raisers in Argentina. One of their worst mistakes, he says, is in planting more than they can properly care for or harvest. They begin gathering too early, before there is any frost to perfect ripening, and later are unable to get help to gather in the best months. The husking is carelessly done, often on rainy days and early in the morning when it is wet, and wet husks and dirt are taken with it. Farmers are advised to undertake no more than 110 to 130 acres to a family and work it better.

Often it is impossible to fill a ship with a good quality of corn, and at last the cargo is completed with grain that should never have gone

in. Probably the ship has been waiting for many days, badly and slowly loaded, with open hatches in wet weather. She may be overloaded at Rosario and have to wait a week or more for high water to cross the bar at Martin Garcia, just above Buenos Aires. In this way the cargo is given every opportunity to absorb moisture before sailing. This generally results in heavy losses at the point of destination.

Mr. Goodwin is quite sure that if ripe Argentine corn is shelled in dry weather and loaded promptly on a ship sailing at once, with the hatches tightly closed during the entire voyage, there will be no trouble at destination. He says it is "not only richer in food constituents, but of much better carrying nature than either North American or Danubian maize." Shipments must be made from Argentina before summer, because in the intense heat the "maize fly," or "palomita," and various micro-organisms develop. Besides, the wheat crop is then demanding the attention of the farmers, and wool shipments are at their height.

Under date of March 10, 1901, Mr. Goodwin, in a circular to the grain trade, expressed the following opinions concerning the shipment of corn and ventilation on board:

A seed grain must be considered as a living entity, composed of minute cells, although its activity of life can be suspended for a long time under certain conditions; and we must study the most practical and economical method of providing those conditions.

It may be roughly said that moisture, air (oxygen), and sufficient heat are necessary for animal or vegetable life, including micro-organisms, and that the active life of a seed can be suspended for a time if any one of the three be withheld.

Of course the best thing to do with grain is to make it really dry and keep it so; but apart from the difficulty of this work in damp weather, on farms or in ordinary warehouses, it must be remembered that grain, especially maize, absorbs moisture from the atmosphere, and also that somebody loses money when grain loses weight. Furthermore, there is a point beyond which drying is unnecessary for the after processes of milling, etc.; and it may be more economical to exclude the second factor, air.

At this point we come to consider the reasons for what is called ventilation on board ship and to note that when grain is thoroughly exposed to air it does not suffer from an excess of heat, as for instance, when in thin layers on a warehouse floor, or when bags are stowed in open order, and in that way it is protected from fermentation, but not from moldiness.

The ventilation in a steamer's hold has a very local and partial effect on the entire mass of grain, and was designed for letting out gases, being advisable for coal cargoes, but without any scientific reason for grain cargoes; and cargo surveyors say that the greatest amount of damage is to be found within range of the ventilators, the least being at the bottom of the hold where there is least access of air, of course always supposing the grain to be of similar quality and condition. In fact, it may be said that ventilation, if thorough, is effective, but if partial is very dangerous.[a]

[a] In another and subsequent article, of an official character, Mr. Goodwin said: "It is dangerous to trust ventilation to any one but an expert. It is easy to let out heated, expanded air, but if cold, damp air is admitted it will increase the fermentation. If a competent person was in charge, possibly a little ventilation during hot and dry weather might be good, but as a rule it is to be guarded against."

Heat, the third factor, may come from the sun, but on board ship may be the result of some grains germinating, or else it comes from direct fermentation. The heat generated in brewers' vats is well known, and Pasteur demonstrated that it is microbic action, but we do not always consider that the mechanical action of a growing seed develops a considerable amount of heat, and this heat may, in a grain cargo, cause fermentation.

The investigation of what is called heating of grain is complicated early in the season by what is called "sweating," a natural process happening at uncertain periods, which has so far not been scientifically explained. We know from experience that grain is improved by sweating and loses moisture, so that fresh grain may sweat on board ship and yet arrive in good order; also, that it should not be disturbed during the process, but it is sometimes difficult in practice to distinguish from fermentation, and further information is badly wanted.

In another circular Mr. Goodwin said:

Ventilation (before shipping) is especially necessary for the removal of the fluff and the mealy dust which comes from the point of the maize grains, which can not be properly removed at the time of shelling and causes much of the heating afterwards. A few frosts are always to be counted on to kill the plants: but there is nothing answering to the winters of the United States; although during October and November the weather is almost always suitable for shipments, and by that time the grain has become dry. With December, however, comes wheat harvest and also considerable heat, which develops weevils and maize fly, and prevents the carrying over of grain to another year; so that under the present conditions of the trade there are only some three months of entirely good weather for shipping an export surplus that may any year amount to 2,000,000 tons.[a]

ANTISEPTIC GRAIN STORAGE.

In September, 1900, Mr. Goodwin published the following letter in London advocating the shipment of corn in chambers sterilized with carbonic acid gas:

Business men are sometimes slow in making practical use of scientific discoveries: and although a large quantity of grain, and especially Argentine maize, that is shipped in apparently good condition, arrives in Europe heated and decayed, the real cause of this trouble does not seem to be studied according to the lights of modern science; nor is the fact that Indian peasants can keep their grain for many years in underground pits appreciated properly.

Some twenty-five years ago Pasteur demonstrated that fermentation does not result from the generation of gases, but from the action of living microbic organisms; and it is now known to bacteriologists that some 95 per cent of the germs which cause fermentation in grain require oxygen as well as a certain amount of heat and moisture for their development. It is also known that under favorable conditions their rate of increase is prodigious.

The vitality of these germs can be suspended by a sufficiently low temperature, as is done in refrigerator chambers for fresh meat; and although it is impracticable to apply cold storage to cargoes of grain it should be easy to sterilize the air in the holds of a steamer sufficiently to retard fermentation without causing any injury to the grain or to the crew, if suitable precautions are taken. On the other hand, what is called "ventilation" of the holds is surely a grave error if Pasteur is right, and must assist fermentation just as the admission of fresh air assists combustion in a furnace.

[a] The exportation of the present year will, it is estimated, equal that amount.

It is interesting to note the arrival last week in London, free from weevils and in perfect condition, of a cargo of Argentine maize which appears to have been treated antiseptically; and this has occurred at a time when all other Argentine maize cargoes are arriving in bad order and when claims for damage during the voyage have been settled for some £12,000 in one week.

Attention has been called to this cargo because a grain sampler, who, without permission, removed the hatches of one of the holds and went down, became insensible and died forty-eight hours afterwards from the effects of inhaling carbonic acid gas. Evidence was given at the inquest to the effect that the maize had been sprinkled during shipment with some chemical preparation and that the holds had been kept closed during the voyage. A verdict of accidental death was given, but the jury censured the shippers for using chemicals and the captain of the steamer for having allowed them to do so, and also for having neglected to ventilate the cargo; a verdict that may have unpleasant after consequences, because of precedents established by the rulings of judges.

About three years ago the owners of the steamship *Belasco* were condemned to heavy damages because some of the hatches and ventilators were closed during the voyage; and many steamship owners immediately gave their captains notice that they must be able to prove that ventilation had been provided and used, notwithstanding any instructions to the contrary on the part of shippers of the cargo.

Chemists say that inexpensive compositions of a perfectly harmless nature in their after effects on human food can be used to sterilize an air chamber—that is, either to consume or drive out the oxygen contained in atmospheric air—and that their application to the holds of a steamer or to suitable warehouse silos would only need reasonable precautions: but it is very desirable that some joint action be taken by grain trade and steamship associations, not only to arrange for a careful study of the entire subject in order to ascertain what methods are safe and efficacious, but also to protect, as far as possible, from unfair legal penalties shippers and others who make the necessary experiments; because when juries or arbitrators have to decide on cases of death by misadventure or damage to produce there is always a tendency to deal harshly with any departure from old methods.

The logical sequence of Pasteur's discovery should be a radical change in the method of storing grain, and indeed nearly all other food products; and it would appear that the air in storage chambers, at sea or on land, can be more economically sterilized with carbonic acid gas than by any refrigerating process. The subject being of national importance calls for proper investigation.

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U. S. DEPARTMENT OF AGRICULTURE.

Report No. 76.

REPORT

OF THE

SECRETARY OF AGRICULTURE.

1903.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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REPORT

OF THE

SECRETARY OF AGRICULTURE.

To the President:

I have the honor to submit herewith my Seventh Annual Report as Secretary of Agriculture.

EDUCATIONAL REQUIREMENTS OF AGRICULTURAL RESEARCH.

The research work of the Department of Agriculture covering the sciences of production in the fields and other laboratories where the crops of the country are grown and where they are made more valuable by skill, has required a class of experts not educated by the institutions of learning where our people have heretofore been prepared for their life work. The development of the Department toward doing all that should be done to help our people secure a greater yield from the soil and enhance the value of its products, made the training of experts in the Department a necessity.

The country needed scholars along all the lines of work considered in this report. The agricultural colleges of the States are the natural sources from which students for this work should be expected to come, and we have availed ourselves of all the competent graduates of these institutions that could be induced to take up advanced work with us; but the demand has been so great, and the growth of the Department so rapid, that we have been compelled to seek the most competent men wherever we could find them.

The theory of our duty is to help any locality that is struggling with a problem to an early solution of which the experience of our scientists may contribute or where the undertaking is beyond the means at the disposal of the people interested.

To these ends many specialists must be trained, and for these purposes the Department has become a post-graduate institution where groups of sciences are taught and applied. Comparatively little time is devoted to the ascertainment of abstract scientific facts. Every worker is helping somebody, and while doing this he is contributing to what is known relating to the farm, and to the education of his associates.

Four hundred and ninety-six students have been admitted to the Department for instruction since 1897 as experts in our several lines of work. Two hundred and forty-nine of these still remain with us, not less than 132 having passed into the classified service; 185 have gone elsewhere to teach, experiment, or demonstrate in private enter-

prise what they have learned from their teachers, who are our best-equipped scientists in their several specialties.

The Department has been extending its work in all parts of the country during the past year wherever the producers from the soil most need help. Our most active efforts have been directed to the stamping out of foot-and-mouth disease in four of the New England States, and in studying the cotton boll-weevil in Texas and demonstrating the growing of cotton successfully in spite of the presence of the pest. Encouraging progress has been made in all the lines of research with which the Department is charged.

OUR SURPLUS PRODUCTION.

Out of their continued abundance, during the past year, the farmers of the nation have contributed food and raw materials for manufactures to hundreds of millions of people in foreign countries, besides sustaining 80,000,000 at home.

A survey of half a century discovers the remarkable character of the movement in which the farmers of this country have become the chief purveyors of the world.

In 1851 our shipments of farm products were valued at $147,000,000, while half a century later, in 1901, they amounted to $952,000,000, an increase of $805,000,000, or about 550 per cent. The farmers' export trade for the decade 1851–1860 amounted to $1,896,000,000, and in the following decade, in spite of the transfer of multitudes of men from productive to destructive life, the total was $2,431,000,000. In the decade after that, the export trade doubled and amounted to $4,864,000,000. In the next decade, the amount grew to $5,740,000,000, and the total for the decade of 1891–1900 was $7,032,000,000, or an average of over $703,000,000 a year. Subsequent to the last-named period this trade has gone on increasing and reached its highest amount in 1901 with exports valued at $952,000,000. The export trade in farm products for 1903 was valued at over $878,000,000, an amount second only to that of 1901.

The consumption of cotton in this country is now greater than that of any other country, and yet the cotton planters of the South not only supplied this market last year, but exported a surplus of 3,569,000,000 pounds, valued at $317,000,000, or for every working day in the year about 12,000,000 pounds, worth more than $1,000,000.

Represented in value, the exports of grain and grain products had about two-thirds of the importance of cotton in the last fiscal year, the value of the export being more than $221,000,000. From 46,000,000 acres of wheat there was a surplus for foreign mouths amounting to 114,000,000 bushels and 20,000,000 barrels of flour, amounts that together represent 204,000,000 bushels of wheat.

Third in importance are the exports of meats and meat products, with a grand total of $178,000,000, to which may be added $35,000,000 for live animals. Quantities that are beyond the grasp of the mind represent the exports of meats and their products. The pounds of beef were 385,000,000; of pork, 551,000,000; of lard, 491,000,000; and of oleo oil, 126,000,000.

The foregoing figures, it should be borne in mind, do not stand for the total production of the farms, but for the surplus production after the wants of the people at home have been satisfied.

THE FARMER'S BALANCE OF TRADE.

The immense exports from the farms of the country lead to an examination of the so-called balance of trade. This examination reveals what seems to have escaped the attention of the public, and that is, that the favorable balance of trade, everything included, is due to the still more favorable balance of trade in the products of the farm.

During the thirteen years 1890–1902 the average annual excess of domestic exports over imports amounted to $275,000,000, and during the same time the annual average in favor of farm products was $337,000;000, from which it is apparent that there was an average annual adverse balance of trade in products other than those of the farm amounting to $62,000,000, which the farmers offset and had left $275,000,000 to the credit of themselves and the country.

Taking the business of 1903, the comparison is much more favorable to the farmers than during the preceding thirteen-year period, since the value of domestic exports over imports was $367,000,000, the entire trade being included, while the excess for farm products was $422,000,000, which was sufficient not only to offset the unfavorable balance of trade of $56,000,000 in products other than those of the farm, but to leave, as above stated, the enormous favorable balance of $367,000,000.

During the last fourteen years there was a balance of trade in favor of farm products, without excepting any year, that amounted to $4,806,000,000. Against this was an adverse balance of trade in products other than those of the farm of $865,000,000, and the farmers not only canceled this immense obligation, but had enough left to place $3,940,000,000 to the credit of the nation when the books of international exchange were balanced.

These figures tersely express the immense national reserve-sustaining power of the farmers of the country under present quantities of production. It is the farmers who have paid the foreign bondholders.

MAGNITUDE OF PRODUCTION.

The height to which farm production has risen to supply the demands of domestic and foreign consumption should not be overlooked. Taking the range of recent years, there is the product of wheat, 600,000,000 to 750,000,000 bushels, worth to the farmer from $350,000,000 to $450,000,000. On more than 90,000,000 acres grow 2,000,000,000 to 2,500,000,000 bushels of corn, with a value which ran up to more than $1,000,000,000 on the farm in 1902.

The oat crop now reaches close to 1,000,000,000 bushels, with a value of $300,000,000; the barley crop overruns 100,000,000 bushels, worth $50,000,000, and the rice crop in 1902 amounted to 390,000,000 pounds.

One of the most valuable three of all farm crops is that of hay, aggregating about 50,000,000 to 60,000,000 tons, worth $450,000,000 to $550,000,000; ranging between 200,000,000 and 300,000,000 bushels is the potato crop.

The acreage of the cotton crop has displayed a tendency to increase considerably during the last few years, and in 1903 was about 29,000,000 acres; the number of bales produced in recent years ranges

from 10,000,000 to 11,000,000, while the value of the entire crop on the plantations has gone as high as $511,000,000 for the crop of 1900, or, if the seed is included, $530,000,000.

Tobacco is another crop of expanding proportions, and the prospect now is that within a few years ten figures will be required to represent the annual production. This crop has now climbed close to 900,000,000 pounds, valued at $60,000,000.

Only some of the principal farm products have been mentioned, but these are sufficient to indicate, in conjunction with information concerning the less important products, that the value of all farm products not fed to live stock for 1903 considerably exceeded their value in the census crop year 1899, when it was $3,742,000,000.

NATIONAL STOCK OF FARM ANIMALS.

The Department's inventory of farm animals January 1, 1903, discovers that while some classes of animals are only holding their large proportions, others are increasing. The horses number 16,557,000, with a value of $1,031,000,000. The mules have increased to 2,728,000, with a value of nearly $200,000,000.

Dairying shows marked expansion, and now depends upon 17,105,000 milch cows, with a value of $517,000,000. Other cattle of all sorts number 45,000,000, with a value of $824,000,000.

The number of sheep has had a tendency to decline at times during the last score of years, but within the last four years has increased decisively, so that now the sheep number 64,000,000, with a value of $168,000,000.

Hogs have remained about stationary in number for many years, and in 1903 were found to be 47,000,000, with a value of $365,000,000.

BETTER DISTRIBUTION OF PROGRESS.

There is one other particular feature of the farmers' improved and gratifying condition that should be noticed, and this seems to have escaped attention. During the long period of time when the new and productive land of the West was easily obtained, and when the number of farms and the amount of production there multiplied at an amazing rate, the farmers of the East and the South suffered under a severe competition and an impending overproduction, and agriculture in these sections, apart from cotton production, was outstripped in the agricultural expansion of the West. Since 1890, however, there has been a turn in the trend of this expansion; the northern half of the Mississippi Valley is not overshadowing the other sections of the country in its rate of expansion as formerly; an improvement in the welfare of farmers in other sections of the country, as well as in the North Central States, is in evidence. In other words, there is a more even distribution of expansion, progress, and welfare than before.

The South, which had been backward in its corn production for many years preceding 1890, finds itself since that time with its fraction of the national production of corn increasing faster than that of any other section; the same is true with regard to wheat, sweet potatoes, and cane and sorghum sirup; and to these may be added tobacco and farm-made butter, and horses, mules, and swine. The South occupies a second place in the rate of increase of production, in comparison with other

sections, in buckwheat, hay, apple and peach trees, cattle other than milch cows, and farm-made cheese.

In a similar way, agriculture in the East is rehabilitating itself by gaining faster than in other sections of the country in the production of buckwheat and potatoes, while it stands second in order among the different sections in its increasing production of rye and of sweet potatoes, and in the number of milch cows.

The group of States embracing the Rocky Mountain and Pacific Coast region is showing a larger gain relatively than other sections in the production of rye, hay, apple trees, and farm cheese, and in the possession of sheep and milch cows; while it holds a secondary place in relative advancement in the production of wheat, oats, barley, potatoes, and farm butter, and in the possession of horses, mules and swine.

The North Central States have by no means lost for all products the foremost place in rapid rate of advancement that they have enjoyed for many years. Since 1890 this section has increased its production faster than other sections for oats, barley, flax, peach trees, and cattle other than milch cows; and this section does not stand second in rate of advancement in any of the products under consideration.

Thus, it appears that a new life has come to agriculture in all parts of the country, and that there are achievement, hope, and promise for the farmer everywhere.

The above review of our agricultural products and exports is presented not only in grateful acknowledgment of the bountiful Providence which has so generously filled our cup of prosperity, but also from a desire to present thus succinctly to the statesmen and to the men of affairs of this country the value and importance of this vast agricultural industry, supported by three-eighths of our working population, and contributing so greatly to the prosperity of the whole country. It is this vast constituency and still vaster industry that the Department of Agriculture is charged to protect, cherish, and encourage, and its extent can only be appreciated by those who are not brought continuously in direct contact with it, by the perusal and study of the foregoing figures and consideration of the important facts they present.

WEATHER BUREAU.

The Weather Bureau has, through its officials at the various stations throughout the country, taken an active part in public education along meteorological lines. In 12 colleges or universities during the past year Weather Bureau officials have conducted regular courses of lectures or classes of instruction in meteorology and climatology, and at 5 of these institutions the official is a member of the faculty. At 16 stations the officials have delivered occasional addresses outside of their offices to schools or colleges, and at 28 stations they have given frequent talks in their offices to pupils and teachers of schools. In 14 instances they have delivered occasional addresses outside of their offices to farmers' institutes and similar organizations. Only a few years ago there was very little instruction of this nature given in our colleges, universities, or public schools, but the demand for it has rapidly increased. The action of the Bureau in this direction will undoubtedly result in a wider knowledge and a more intelligent understanding of its work, and a consequent increase in its usefulness and

value. Many of the young men who receive instruction in these classes are attracted to the service of the Bureau as an occupation, and the Bureau profits by securing a class of employees with special training and equipment.

The year 1902–3 marks a distinct advance by the Weather Bureau in the science of meteorology, especially in two directions. From the beginning of the weather forecasts by the Government, in 1871, the necessary observations at the several stations have always been reduced to the sea-level plane. It was conceived some years ago that the numerous defects in forecasting might be diminished, and the uncertainty as to the true cause of storms removed, if similar daily charts were also constructed at higher levels, for which purpose the 3,500-foot and the 10,000-foot planes were selected. After much laborious computation, as shown in the barometry report of 1900–1901, the necessary reductions were made, and we now possess daily weather charts on the three planes mentioned. The study of these supplementary maps is going on, with encouraging prospects of more reliable forecasts of the weather conditions, and it is hoped by January 1, 1904, to make them a part of the regular daily work of the forecasting service. At present the improved data are confined to the barometric pressures, but it is most important to secure charts of the temperature on the two upper planes as well. Unfortunately, we have no observations of temperature in the higher atmosphere suitable for this purpose, and they can be secured only by means of numerous balloon and kite ascensions carrying the necessary self-registering instruments.

It has been thought proper for many reasons to establish on the Blue Ridge Mountains, at Mount Weather, Bluemont, Va., a modern meteorological observatory of the best class for scientific research pertaining to problems of weather phenomena. A building for administration and for a school of instruction is being erected, and the plans are well advanced for a suitable power house and shop for balloon and kite ascensions, which will be built during the coming year. The recent advances in solar and terrestrial meteorology justify us in preparing to study at first hand the variations in the solar activity, and the corresponding changes in the weather conditions, especially from season to season. It is a complex problem and will require the best instrumental equipment, the ablest students, and a long series of observations before it can be finally solved. The desirability of being able to foresee a year in advance the type of season probable during a given period is so great as to make it imperative to lay broad scientific foundations at the beginning of the twentieth century, which will be of utility for future generations, who will surely build a great science of cosmical meteorology upon such data as can be supplied by the Mount Weather Observatory.

SUBMARINE CABLES.

New submarine cables in connection with the vessel-reporting and storm-warning services have been laid from Sand Key to Key West, Fla.; from Southeast Farallone to Point Reyes, Cal.; from Block Island to Narragansett Pier, R. I.; and from Glen Haven to South Manitou Island, Mich., a total of about 50 miles. Additional vessel-reporting stations have been established at Sand Key, Fla., and Southeast Farallone, Cal.

To meet the demands of the maritime and commercial interests of the Pacific coast a cable has been laid to connect San Francisco and the Farallone Islands, with a weather observatory and vessel-reporting station on the South Farallone Island. A wireless station has also been installed there to insure communication in future should the cable be out of order.

RIVER AND FLOOD SERVICE.

The work of the river and flood service, owing to the numerous and disastrous floods that occurred, has been a prominent feature of the year. Several of the floods were the greatest of which there is authentic record, and were remarkable both for their wide extent and for their destructive character. Our warnings were prompt and timely, and in the main remarkably accurate; and in no instance was the coming of a dangerous flood unheralded. The forecasts of the great floods of March, April, and June, 1903, afford noteworthy examples of the efficiency of this service. This should be extended to the Kansas and other rivers, where no stations have yet been established.

DISTRIBUTION OF FORECASTS AND SPECIAL WARNINGS.

Inadequate appropriations have prevented any extensions in the important work of distributing forecasts and special warnings, and of necessity our efforts have been confined to maintaining the service already in operation, with its various ramifications, and adopting such suggested improvements as might be effected without additional expense.

A marked increase (nearly 20,000) is shown in the number of places receiving forecasts by telephone without expense to the Government of the United States, and with the rapid extension of "farmers' telephone lines" opportunity is afforded for placing weather information directly in the homes of the more progressive agriculturists, as well as in the telephone exchanges of rural centers of population, where it is posted for the general information of the public.

NATIONAL CLIMATE AND CROP BULLETIN.

The National Climate and Crop Bulletin has been issued in the usual form, with charts showing the current temperature and precipitation, extremes of temperatures, and the departures from the normal of both temperature and precipitation. In this bulletin the current meteorological conditions are discussed in their relation to crop growth from the beginning to the end of the crop season.

BUILDINGS ERECTED AND PROPOSED.

During the past fiscal year, through the appropriations by Congress, it has been possible to erect buildings for use as meteorological observatories for the Weather Bureau at the following-named places, and at a total cost of $32,922.97, viz: Amarillo, Tex.; Modena, Utah; Key West, Fla.; Sand Key, Fla.; Southeast Farallone, Cal.; and buildings are now in course of erection at the following places, the total cost of which will be $70,900, viz: Yellowstone Park, Wyo.; Duluth, Minn.;

Devils Lake, N. Dak.; Havre, Mont.; Mount Weather, Va.; Block Island, R. I.; Narragansett Pier, R. I.

The wisdom of erecting buildings for the exclusive use and under the control of the Weather Bureau becomes more apparent every day. It saves to the Government the amount heretofore paid for rent of office quarters, which in many cases are unsuited to our needs, especially as regards the architecture of the roofs for the exposure of meteorological instruments.

BUREAU OF ANIMAL INDUSTRY.

A marked distinction between our country and all others is the more generous nutrition of our people. Our domestic animals contribute to this result, and furnish a large percentage of our exports. This has been brought about by abundance of comparatively cheap grass and grain rather than through superior knowledge of breeding and feeding. We have developed a track horse, a lard hog, and but little else.

The Bureau of Animal Industry has given standing in interstate and foreign commerce to our animals and their products, and is battling successfully with diseases and disabilities originating at home and abroad. It is considering the wisdom of undertaking systematic cooperation with the State experiment stations in the production of types of animals suited to our varying latitudes and conditions, in order that more economy may be observed in production.

CONTAGIOUS DISEASES OF ANIMALS.

The control of the contagious and infectious diseases of animals is one of the most important lines of work in which the Department is engaged, and this work must become more valuable and of greater necessity as the number of animals in the country increases and as traffic with countries in which such diseases exist is further developed.

FOOT-AND-MOUTH DISEASE.

Last year, for the first time in eighteen years, foot-and-mouth disease was discovered in the United States. The manner in which the contagion was brought in is not definitely known, but it evidently came with some articles of merchandise, as it first appeared near the docks of the port of Boston, and spread from there toward the interior. When the existence of this disease was recognized and brought to the attention of the Department the contagion had already spread over the eastern part of the State of Massachusetts and into the States of Rhode Island, New Hampshire, and Vermont. The whole country was menaced with the plague, and it was only by the adoption of radical measures and by the prompt, efficient, and indefatigable work of the inspectors that the contagion was controlled and eradicated.

The plan of work was, briefly, to rigidly quarantine all infected premises and the animals upon them, to slaughter at the earliest practicable moment all susceptible animals on such premises, and to disinfect the stables, pens, and utensils in a thorough manner. Operations were begun December 1, 1902, and the last diseased herd in this outbreak was slaughtered May 9, 1903. The cooperation of the executive

departments of the several affected States was prompt and complete, and enabled the Federal authorities to enforce regulations and stamp out the disease wherever it was found. The number of animals slaughtered on account of this disease was 4,461, of which 3,872 were cattle, 360 hogs, and 229 sheep and goats. There was allowed by this Department 70 per cent of the appraised valuation as indemnity. The total amount thus paid was $128,908.57. There were other expenses, such as for salaries, traveling, labor, disinfectants, etc., which were additional to this amount, but the total cost of the eradication of the disease was less than $300,000.

The stock raisers of the country were saved from a great calamity by the successful termination of this work. It is the general history of the disease in other countries that where an outbreak assumes the proportions of the one which existed in New England last winter it spreads over the whole country, affecting sooner or later practically all of the cattle and a large part of the sheep and hogs. As the value of grown cattle shrinks from 20 to 30 per cent in consequence of the disease, as some of these die, together with a considerable proportion of the young animals, and as hogs and sheep are also seriously affected, it is plain that the direct losses from a general extension of the contagion over the country would be some hundreds of millions of dollars, while the indirect losses from domestic quarantines and restrictions on traffic and from embargoes on our export trade would be simply incalculable. These losses were avoided, because the Department had a force of competent and trained veterinarians who were at once taken from their duties in other parts of the country and concentrated in the infected section, and who loyally and cheerfully endured the hardships of a winter campaign in the rural districts, where the cold much of the time was extreme, the roads blocked with snow, and the difficulties connected with the disposal of the carcasses of slaughtered animals and the disinfection of the premises were almost insurmountable.

SHEEP SCAB.

Energetic work has been carried on during the year with the object of controlling as effectually as possible the contagious disease of sheep known as scabies, or scab. Heretofore but little has been done for the repression of this disease except in the channels of interstate commerce, and it was hoped that the prohibition of the shipment of diseased sheep would be sufficient to cause the owners of such animals to treat them on the farms and ranges, and thus eradicate the contagion. While this result followed in some cases, it is unfortunately true that the greater part of the owners of this class of animals have neglected to take proper measures and have apparently relied upon their ability to elude or deceive the inspectors and run their animals through to market without the actual condition being discovered. The attempts to accomplish this have kept the stock cars and stock pens used for animals in interstate commerce so thoroughly infected that satisfactory progress with the disease could not be made. It was therefore determined to cooperate with some of the worst infected States, and attack the contagion at its origin by stamping it out on the premises where it exists and propagates from year to year. This has required somewhat of an increase of the field-inspection force, but it is apparently only in this way that the disease can be controlled.

The inspectors have inspected in this work during the year an aggregate of 16,444,370 head of sheep, and have supervised the dipping of 2,167,002 sheep, of which 394,636 were dipped twice. This enormous amount of work has had great influence for good, and if continued for a few years, will free the sheep industry from this incubus, which has for many years been the source of great discouragement and loss.

TEXAS FEVER.

The inspection and supervision of cattle in transit from the Texas-fever district has also involved a great amount of work. These animals are capable of spreading contagion through the ticks with which they are infested, and must, therefore, be kept in different cars and yards and driven over different roads from those used for other cattle. It is moreover necessary to inspect many cattle from the district adjacent to the infected section in order to determine definitely that they have not been exposed, and that they may safely be allowed to go forward to market through the channels of interstate commerce without danger to the animals of any other section of the country. This service required the inspection of 1,620,403 cattle from the infected district, and of 389,525 cattle from the adjacent district. To guard against the spread of the contagion by infected cars, 66,116 of these were cleaned and disinfected by the direction and under the supervision of the inspectors.

It is well known that if Southern cattle are entirely freed from that species of ticks known as the *Boophilus annulatus* they can be allowed to mingle with the most susceptible animals without danger. Many efforts have been made to discover a practicable method for destroying this parasite without injuring the cattle, and the Bureau of Animal Industry has experimented for years with this object in view. Such treatment, if successful, would relieve most of the Southern cattle from quarantine restrictions, and would make these cattle bring more money in the markets of the country. After many failures, apparent success has been reached by dipping the cattle in the crude oil obtained from certain Texas wells. This oil is heavily charged with sulphur, and in the experiments so far made has not materially affected the cattle. It is necessary to regard such a treatment with some reserve until a large number of animals have been treated under the conditions which obtain in the practical shipment of cattle from the infected district to the markets; but it may be said now that this oil has been tried at the animal industry experiment station near Washington with entirely successful results, being distinctly superior to any other substance tested, and that it has also been tried in the field with about 70 head of cattle, the effect being equally favorable. Arrangements are now made for using the treatment on a much larger number of animals, and if, as hoped, no objections to it develop, it will be of inestimable value to the cattle industry of the Southern States.

HOG CHOLERA.

The losses from contagious disease among hogs in the United States have been enormous, probably reaching in some years the aggregate of $75,000,000, and being seldom less than $30,000,000. This Department has for a quarter of a century been conducting scientific experiments with a view to elucidating the nature of the disease and develop-

ing some practical treatment by which it might be controlled; and while much has been discovered as to the effects of certain bacilli, and as to the desirability of sanitary measures, no satisfactory method of controlling the disease has been evolved. Recently it has been shown by the Bureau of Animal Industry that there is, at least in some of the outbreaks, a different cause at work from what has heretofore been suspected. When the bacilli which have been supposed to cause the disease are all filtered from the blood, this liquid is still capable of producing the malady and has apparently the same degree of virulence as it had before filtering. It is yet too early to estimate the proportion of the losses attributed to hog cholera which are caused by this agent, which passes through the finest filters, and which in this condition must be too small to be revealed by the highest powers of the microscope. Investigations are now being made to throw some light upon this question; but enough is already known to make it probable that this discovery will prove of very great importance.

TUBERCULOSIS.

Investigations have been conducted with human and animal tuberculosis, with a view of determining whether the disease is transmissible from man to animals or from animals to man. It has been shown by the experiments which have been made that there are cases of human tuberculosis in which the bacilli are as virulent for cattle as are the bacilli obtained from animals affected with the disease. The conclusion from this fact is that either human and animal tuberculosis are identical and intercommunicable or the persons from whom these virulent bacilli were obtained had been infected with bovine tuberculosis. In either case, it must hereafter be admitted that the tuberculosis of animals is a menace to human health, and that both for economical and for sanitary reasons measures should be adopted for its control.

BLACKLEG.

The work against blackleg continues satisfactory. During the season the Bureau vaccine was used with 775,877 cattle, and the percentage of deaths after vaccination, not counting those animals that were evidently diseased before vaccination, was 0.53; whereas before vaccination the average percentage of losses among the same herds was 2.69.

INSPECTION OF ANIMALS AND ANIMAL PRODUCTS.

The number of certificates of inspection issued for American cattle exported to Europe was 960. The number of clearances of vessels carrying live stock was 634. The number of sheep inspected for export to Europe decreased from 211,224 in 1902 to 111,448 this year. The exports of horses fell off very considerably also, being 3,910 this year, as against 10,967 in 1902. Of the 228,365 cattle inspected for export, 226,613 went to Great Britain.

MEAT INSPECTION.

In the meat-inspection service the number of ante-mortem inspections was as follows: Cattle, 11,988,760; sheep, 14,654,249; calves, 1,041,138; hogs, 31,546,222; horses, 344; a total of all animals of

59,230,713. The following post-mortem inspections were also made: Cattle, 6,165,890; sheep, 8,598,175; calves, 670,173; hogs, 21,827,047; horses, 344—a total of 37,261,629.

The meat-inspection tag or label was placed upon 21,124,318 quarters, 362,689 pieces, and 186 sacks of beef; 8,571,643 carcasses of sheep; 667,259 carcasses of calves; 880,945 carcasses of hogs, and 696,279 sacks of pork.

The meat-inspection stamp was affixed to packages of meat products that had received the ordinary inspection, as follows: 7,520,854 of beef, 59,314 of mutton, 14,601,202 of pork, and 70 of horseflesh—a total of 22,181,440.

The number of cars sealed containing inspected meat products for shipment from official abattoirs and other places was 67,046.

The number of certificates of ordinary inspection issued for meat products for export, exclusive of horseflesh, was 30,152. Of beef, there were 1,388,633 quarters, 20,422 pieces, 401 bags, and 1,352,291 packages, with a weight of 371,920,737 pounds; of mutton, there were 35,394 carcasses and 22,527 packages, weighing 2,729,013 pounds; of pork, there were 24,380 carcasses and 506,311 packages, weighing 133,122,610 pounds.

The decrease in the certified exports of beef and pork, noted in the last report, continued, the figures showing a decline from the last year of 45,070,025 pounds of beef, and 55,237,401 pounds of pork. The exports of mutton were nearly two and a half times as much as last year, when there were 1,145,248 pounds certified.

There was one shipment of horseflesh, 70 packages, weighing 28,000 pounds.

The cost of the work of the ordinary meat inspection for the year was $711,546.18.

MICROSCOPICALLY INSPECTED PORK.

The exports of microscopically inspected pork to countries requiring inspection decreased 14,572,888 pounds—from 33,681,229 in 1902 to 19,108,341 in 1903. The cost of the microscopic inspection was $78,179.63, being an average of 16 cents for each examination, and for each pound exported 0.41 cent.

IMPORTS FROM MEXICO.

There were imported from Mexico 52,780 cattle, 4,119 sheep, 1,794 goats, and small numbers of other animals. At seacoast ports there were imported 2,602 horses and 169 ponies.

RENOVATED-BUTTER INSPECTION.

The inspection of dairy products under the act of March 2, 1902, was continued. Repeated inspections were made of 82 renovated-butter factories, located in 17 States, and the quantity of butter made by these was 54,656,800 pounds. This was an increase of 9 per cent over the previous year.

BUREAU OF PLANT INDUSTRY.

The work of the Bureau of Plant Industry has been pushed with vigor during the year. The advances made and the suggestions and

recommendations for future work are set forth under the accompanying headings, and are believed, in all cases, to be for the betterment of agricultural conditions in the United States.

COOPERATION WITH THE EXPERIMENT STATIONS.

The Bureau is cooperating now with more than forty State experiment stations along many varied lines. The improvement of forage crop conditions, the extension of the work on cereals, the testing of new seeds and plants from home and abroad, demonstration work in the treatment of plant diseases, etc., are some of the more important problems upon which the stations are contributing to the Bureau.

THE DISTRIBUTION OF SEEDS AND PLANTS.

As set forth in my last report, a number of changes have been made in the securing and distributing of seed for Congressional purposes. Instead of contracting for all the seed and having it put up by one firm, the Department has purchased the seed and arranged for the putting of it up by contract. This is a great improvement over the old method, as it practically removes all opportunities for difficulties which have been encountered in the past in the matter of substituting inferior seeds for those called for, giving short weights, etc. With the enormous amount of seed that has to be purchased in the Congressional distribution, it is impossible to make provision in advance for everything that will be required. If seed were a fixed commodity it would not be difficult to make specific contracts for the delivery of particular quantities at particular times. So much, however, depends upon weather and other conditions that it can never be determined until the harvests are all over as to what seed can and what can not be obtained. For this reason it is not practicable, nor is it desirable, that the Department should endeavor to secure its seed by the ordinary contract system. Inferior seed can so easily be substituted for good that the Department must devote special attention to this phase of the subject in order that nothing but the best may go out.

To accomplish this, seed, for the most part, must be purchased in the open market from men who are known to be reliable and in whom dependence can be placed for furnishing seed according to contract. To protect the Department in all of its interests, inspectors are kept constantly in the field during the growing season looking after the crops that are being grown for the Department and in other ways keeping track of the seed conditions in general, so as to be intelligently guided in the matter of purchases. Furthermore, the Department, by judicious placing of orders for seed, can encourage home industries. This it is endeavoring to do in every case where it is practicable. In a number of instances, where certain kinds of seed are grown to a large extent abroad, the Department has placed its orders with American growers in order to encourage the work in this country. This is particularly the case with flower seed, of which a number of kinds are now being specially grown for the Department on the Pacific coast and elsewhere.

Carrying out the plan as set forth in my last report, special attention has been given to particular crops, such as cotton, forage plants, and other crops. In the matter of cottons an effort has been made to

secure for general distribution varieties which have come to the attention of the Department's officers as valuable sorts, but of local distribution only. The work in this connection has been exceedingly valuable, and many reports have been received as to the greater usefulness of the varieties distributed over those locally grown. The same is true of a large number of forage crops. A particular effort has been made in the matter of distributing home-grown sugar-beet seed. It has been found that sugar-beet seed can be grown successfully in this country, and that the beets from such seed yield a high sugar content. Ten thousand pounds of such seed were distributed last year, and careful work was inaugurated to determine the value of the product from these seeds as compared with seed grown abroad.

With regard to the securing and distributing of miscellaneous garden and flower seed, the fact remains that this work does not accomplish the ends for which the law was originally framed. There are collected, put up, and distributed now, on Congressional orders, nearly 40,000,000 packets of miscellaneous vegetable and flower seeds each year. These seeds are the best that can be obtained in the market, but from the fact that large numbers of packets are wanted, the seed obtained can be of standard sorts only, such as are to be found everywhere for sale in the open market. As there is no practical object to be gained in distributing this kind of seed, it seems very desirable that some change be made. To this end, it would seem wise to limit our work entirely to the securing and distributing of seeds, plants, etc., of new and rare sorts. There is still much to be done in the way of securing seeds, plants, etc., of this kind from abroad, but still more to be accomplished in careful investigations of our own possibilities in this direction. There are many valuable plants scattered all over this country which are still little known outside of their respective localities. These should be collected, tested, and distributed. There are also great possibilities of improving agricultural industries by distributing specially bred seeds and plants.

As the plant-breeding work of the Department increases, opportunities for securing seed of this nature will accumulate. To do this work in the most effective manner, arrangements could be made in all cases to secure the advice and assistance of Senators and Representatives who have agricultural constituents. The Department has a well organized force of scientists who are thoroughly familiar with the general conditions of soil and climate in nearly all parts of the country. Special crops could be selected for special purposes, and with the advice and cooperation of Members of Congress such crops could be placed where they would do the most good. This is a line of work that would result in very much more value to individual districts throughout the country than the distribution of a large quantity of common varieties of garden seed, which have no particular merits so far as newness or promise are concerned. I shall inaugurate the coming year work along the lines here mentioned, and hope to receive the cooperation and aid of Congress in this matter.

NEW SEEDS AND PLANTS FROM ABROAD.

During the past year the seeds secured by our agents in Asia and Africa, to whose explorations reference was made in my last report, have been received and distributed. Special attention was paid this year to the reorganization of the work within the United States. It

was felt that the time had come for more thorough work within this country, since there were many introductions that had not been pushed as they deserved to be. The clerical force was therefore strengthened, and a systematic attempt was made to secure reports from persons who had received seeds and plants. Many of these reports are now on file, and the work of compiling them to make them useful in further work is going on.

GRAINS.

Special attention has been given the grains. New wheats for the Northwest, new oats, new millets, and other crops have been pushed. The work on durum or macaroni wheats has been highly successful. Probably 10,000,000 bushels of this class of wheat were harvested in the crop of 1903. The value of macaroni wheats in the drier portions of the Great Plains is now fully established, and the demand for them is increasing as their value becomes better known. The quality of the wheats is always better in the drier areas, and in general they are not adapted to the ordinary spring and winter wheat districts. Where there is sufficient rainfall for good crops of spring and winter wheats, macaroni wheat should not be grown; especially as it is likely to be inferior in quality to such wheat grown in the drier regions, and could not, under such conditions, bring a price equal to that of the ordinary grades of spring and winter wheats or the better grades of macaroni wheat. There is a constant foreign market sufficient for a good export trade, as soon as the business can be facilitated by opening up the proper trade channels, but the home demand at the local mills is most important and is rapidly increasing. At least 20 mills are now handling this wheat, and there may be others not yet known to this Department. At an average capacity, these mills, running half time on macaroni wheat, would consume between 3,000,000 and 4,000,000 bushels during the year. A large part of the product is in the form of semolina, which is now being used by eight to ten of the most important macaroni factories in the country, all of which had formerly used ordinary bread flour, and a number of which will hereafter use only the semolina from macaroni wheat.

Tests have been made during the year, first by private institutions and some of the experiment stations, and then by the Department, to determine the value of macaroni wheat flour for bread. The results appear to show that a very good quality of bread can be made from such flour. After a number of preliminary experiments by the Department a test was finally made in which 200 loaves, made from macaroni wheat flour, were compared with an equal number made from the highest grade of spring wheat patent. Selected experts among the millers, bakers, flour inspectors, grain dealers, and teachers of domestic economy throughout the country stated their opinions in writing as to the relative merits of the two breads. A consensus of these opinions showed that in this experiment, at least, the macaroni flour made a fine quality of bread.

ALFALFA.

The Turkestan alfalfa seed secured by our agent in Asia was distributed through the active cooperation of Members of Congress. This distribution was made in such a way that it would result in a supply of home-grown seed being available in the future, so that we

may avoid the expense and uncertainty attending the importation of the seed. Reports received up to date indicate that many of the plantings made have been successful, and there is reason to hope that this valuable variety has been permanently introduced into the United States.

Of especial importance will be the introduction of an alfalfa adapted to the alkali parts of our arid Southwest. Work on this problem has been pushed forward during the year. The seed secured by our explorer in Algeria, as well as some sent by our representative from Turkestan, has been planted under the personal supervision of the Department experts. There is reason to believe that this introduction will be successful, in which case it will be possible to reclaim large areas of land in the Southwest that are now too alkaline for alfalfa.

RICE.

The rice work done during the past year demonstrated the very important fact that by the use of proper varieties it is possible to materially extend the period of harvest. This has all along been one of the serious difficulties which the growers have had to encounter, but by the use of varieties which the Department has introduced it will be practicable to sow large tracts and to harvest as the different varieties ripen, without haste and without loss.

FLAX.

The cultivation of flax is one of the oldest agricultural industries in the United States, but it has been forced to move steadily westward to new lands, as it became unprofitable in the older States. It was thought that flax exhausted the soil and could thus only be grown for a few years in one locality, but recent research has shown that the real cause of "flax-sick" land is a disease, the germ of which, living over in the soil, soon makes it impossible to produce flax where this disease is prevalent. The importance of the industry to our Northwestern States may be judged when it is known that in 1901 the State of North Dakota alone produced $19,460,000 worth of flaxseed. To this must be added the growing industry of using the fiber of the seed flax for making binder twine and other coarse materials. This industry is seriously threatened by the same disease that has forced flax culture to move out of the Eastern States, and the Department has sent an expert to Europe in the hope that in some of the provinces of Russia a variety resistant to this disease might be found. In any event, it will be possible to secure better varieties than we now have and to learn how the farmers of Europe have managed to hold this disease in check.

NEW LINES OF WORK IN SEED AND PLANT INTRODUCTION.

Among several new introductions designed especially to meet the needs of the Southeast have been improved varieties of cassava, which gives promise of great value for stock-feeding purposes and starch making; superior varieties of mango for cultivation in the extreme South, and Mexican peaches and apricots which, it is thought, will be better adapted to cultivation in the South than the varieties we now have. A number of plants of a choice variety of pineapple were also

received from South Africa through the generosity of Hon. Barbour Lathrop.

Work has also been begun on the establishment of the matting industry in the United States. At present matting to the value of nearly $5,000,000 is annually imported. A loom has been perfected for weaving the material, and the Department has undertaken the establishing of the cultivation of the raw material.

The Department annually receives many hundreds of packages of seeds and plants from abroad. These are all being carefully tested, and as fast as any give promise of value they will be propagated for further distribution.

The lines of work here enumerated are capable of great extension, and will result, as experience has already shown, in building up new industries of great importance to the country.

DRY-LAND AGRICULTURE.

Nearly one-third of the area of the United States has insufficient rainfall for the best culture of the ordinary crop plants. Considerable tracts of land are already irrigated and much more will be artificially watered in the future; but there must eventually remain enormous areas—doubtless nearly a fourth of the entire land surface of this country—which are doomed to remain perpetually in their present arid or semiarid condition for the want of an adequate supply of water for irrigation. The total rainfall over the lands lying between the one hundredth and one hundred and twentieth principal meridians is inadequate to irrigate more than a small fraction of the arable lands, no matter how carefully conserved and used. Dry farming is then a necessity, in order to utilize such lands where irrigation can never be practiced.

The Bureau of Plant Industry is occupying itself with the future of these regions, and is making a thorough study of the conditions and of the best ways and means of meeting them.

It is believed that not only can the grazing capacity of such lands be increased by intelligent management, but that large areas of such dry, but often extremely fertile, lands can ultimately be utilized for "dry farming." It is believed that as the irrigable lands become more and more completely occupied, there will be an increasing appreciation of the value of, and a greater effort to utilize, the dry, unirrigable lands adjoining settlements founded in the irrigated regions. In the meantime the scientists of this Department are endeavoring to secure plants that will grow in very dry soils, and at the same time yield paying crops that can be absorbed by our markets or profitably utilized on the farm. In order to carry out such introduction of new crops it is necessary to study most carefully the life history of each particular plant, in order to determine with some degree of accuracy its needs as to climate and soil, also its cultural requirements and the best methods of marketing or otherwise utilizing its products. It is only by carrying out in advance a life-history investigation in the most scientific way that it will be possible to introduce such new crops into profitable culture on a commercial scale without running the risk of most costly and discouraging failures.

To extend this important work a small increase in the appropriations has been included in the estimates of this Bureau.

NITROGEN-FIXING BACTERIA.

The fact that leguminous crops, like peas and clover, can obtain nitrogen directly from the atmosphere when certain bacteria are present on the roots has been known for a long time, and many attempts have been made to cultivate and use these bacteria in agricultural practice. Attention has been called in past reports to the progress the Department has made in investigating this problem. At the time of the last report the reason for the failure of former work from a practical standpoint, both in America and in Europe, had been determined, and a new, simple, cheap, and thoroughly satisfactory method of cultivating, distributing, and using these nitrogen-gathering organisms for all important crops had been perfected. During the past season the value of these bacteria has been demonstrated in extensive field tests. Good stands of clover and alfalfa, vetch, cowpeas, etc., have been secured in soils where, without the bacteria, these crops were a failure. The field work also demonstrated that soil and seed inoculation are equally valuable, so that either method may be used according to convenience. As a result of these experiments the Department is now prepared to furnish, in reasonable quantity, organisms for all the principal leguminous crops. Patents have been applied for, covering all the processes used, in order to make them secure for general public use. In order to enlarge the scope of this work and to carry on the necessary field demonstrations, an increase in the funds of the plant physiological and pathological investigations has been included in the estimates.

WATER CONTAMINATION BY ALGÆ.

It is well known that algæ of various kinds play an important part in the contamination of water supplies. The bad odors and tastes which some varieties of these plants give to water make it unpalatable to stock as well as to man. Some of the algæ also smother out aquatic crops, like cress, and furnish breeding places and food for mosquitoes. The physiologists of the Bureau of Plant Industry have now developed a cheap and effective method of exterminating algæ, which promises to be of universal application, in reservoirs, lakes, ponds, etc., where algal pollution exists. Extensive tests are now being carried out in cooperation with various board of health and water engineers, and the results so far have been extremely satisfactory. When the tests have been completed a full report will be issued and the method fully disclosed.

NEW LONG-STAPLE UPLAND COTTON.

Attention was called in the last report to the fact that the plant-breeding experts had secured some hybrid long-staple Upland cottons which promised to be of great value. These are of the ideal type desired, having large bolls, very productive, with long, fine fiber, about 1¼ and 1⅛ inches, borne on smooth black seeds. Preliminary field tests of the varieties have now been completed, and several of the best appear to be already fixed in type and come true by seed. Extensive field tests are under way, and if the results of the present season's work are satisfactory seed will be grown for distribution. Much attention has also been given to the improvement of the ordinary

Upland types of cotton by straight selection. Many growers have become interested in this work, and appreciate the value and importance of careful selection of seed.

EGYPTIAN COTTON.

Another important line of work which is receiving considerable attention at the hands of the Physiologist and Pathologist is the introduction and establishment of the best varieties of Egyptian cotton. We now import annually about $7,500,000 worth of these cottons, and the demand is rapidly increasing. When first introduced, most of these varieties gave comparatively light yields, and in some cases the fiber apparently lost some of its essential characteristics. These difficulties, however, are gradually being overcome as the result of careful selection and breeding. Samples of fiber grown last year in experiment patches have been submitted to experts in this country and Europe, and several of them have been pronounced equal to the best Egyptian. Manufacturing tests are now in progress. The indications at the present stage of experiments favor the belief that we shall soon have varieties adapted to cultivation in this country. The tests are in progress in Georgia, South Carolina, Mississippi, Texas, New Mexico, Arizona, and southern California.

DISEASE-RESISTANT COTTONS.

Great interest has been manifested by planters and handlers of cotton in our work of securing disease-resistant strains or varieties. The wilt-resistant Sea-island varieties distributed by the Department last year and this year have proved highly satisfactory. Wilt-resistant Upland strains have now been developed and are being grown on a large scale this season for the production of seed. Growers in all parts of the cotton belt where wilt occurs have adopted the method of resistant-seed selection recommended by the Department. In infected land the ordinary sorts are a complete failure, while the resistant varieties produce a good crop. Considerable progress has also been made in selecting varieties resistant to Texas root rot, the boll-weevil, and other serious pests.

DISEASES OF SUGAR BEETS.

The work on sugar-beet diseases was continued during the year. The spraying experiments with Bordeaux mixture for the control of leaf blight were entirely satisfactory in holding the diseases in check, and resulted in an increase of approximately 50 per cent in the tonnage. Further investigations were also made of the disease known as curly top, which was prevalent last year and has been even more serious the present season. So far we have been unable to determine the cause of this malady, but there is hope of securing strains resistant to the disease. A small increase in the appropriations for this work has been put in my estimates.

DISEASES OF ORCHARD FRUITS.

The work on diseases of orchard fruits for the past year has been largely in the nature of demonstrative experiments, the idea being to show the practical growers how to put into operation the various

methods of fighting disease. Especial attention has been given to little peach in Michigan and New York. In the former State, in cooperation with the State authorities, the disease has been stamped out of a large area. The principal work in pear blight has been carried on in Georgia. In the north Georgia experiments the treatment was entirely successful, the disease being eradicated from the experimental orchards. In the south Georgia experiments, while the disease was not completely eradicated, the treatment greatly improved the condition of the orchards as compared with the surrounding untreated orchards. From the large field experiments in the past two years the Department now feels certain that bacterial blight of pears and apples can be controlled if the treatment recommended by the Department is carried out thoroughly. Similar demonstrative work will be done in some other pear or apple section the coming season.

DISEASES OF TRUCK CROPS.

The intensive culture of vegetables for home and foreign markets has developed to great proportions in the United States. Wherever crops are grown on an extensive scale the appearance of a disease becomes a serious matter, and often the cause of great loss. In nearly every important truck section serious diseases have appeared, and wherever they have been called to the attention of the Department an effort has been made to determine the cause, and if possible to suggest a remedy. The loss to the cucumber growers in the South Atlantic trucking regions and in the Mississippi Valley was heavy this year, owing to the prevalence of bacterial wilt and downy mildew. Information was furnished to the growers relative to the means of controlling these two diseases. Considerable work was also done with watermelon, tomato, and cabbage wilt. The only way to control these wilt diseases is by the use of resistant varieties. In the case of the watermelon, the citron and some foreign melons have proved to be wilt-resistant, and hybrids between them and the native varieties were also resistant and immensely productive. An endeavor is being made to fix a type of these hybrids. We have also succeeded in obtaining resistant selections from American varieties. With tomato and cabbage a similar line of work has been started, with promise of success. Further tests of the variety of cowpeas known as "Little Iron," resistant to wilt and root knot, have been made during the year, and even in the worst infected soils this variety has proved perfectly resistant. It has been crossed with heavier yielding varieties, with the hope of obtaining improved strains.

CALIFORNIA VINE DISEASE.

Attention has been called from time to time to the progress that has been made in efforts to find a method of controlling the California vine disease, a malady the cause of which still remains unknown. Experiments with grafting stocks have been in progress in the center of the badly infected district for over eight years. These experiments have included the grafting of some 400 acres of vines, the enterprise being conducted in cooperation with leading viticulturists in California. The Lenoir vine is resistant to the disease, and its use either as a top graft

or as a root upon which to graft other varieties has been found effectual in resisting the disease.

New varieties of grape, which have received Lenoir blood through hybridizing, have shown great resistance to the same disease.

So far as this experiment has gone, therefore, it seems probable that a satisfactory means of permanently overcoming the disease has been found.

TIMBER PRESERVATION AND SEASONING.

The work of timber preservation and seasoning has been conducted by the cooperation of the Bureau of Plant Industry and the Bureau of Forestry. The saving caused by improved methods of cutting timber to insure longer life has already been very great. In one instance about $50,000 was saved in six months. Extensive tests were carried on in cooperation with railway, telegraph, telephone, and mining companies, to determine the amount of water evaporated from timber. Drying out timber according to methods suggested by the Department has led to a great saving in freight and increased length of life of the timber, besides resulting in a saving of labor in handling it. Various preservative processes have been tested during the year, and considerable advance has been made in this art as the result of the Department's investigations. Our aim is to secure a process which will be so cheap and effective as to make it within the reach of even the small user of timber.

WORK WITH MUSHROOMS.

An industry of considerable importance has sprung up in this country in the growing of mushrooms for market; but so far it has not reached great proportions, owing to the fact that most of the spawn has to be imported. We also import in the shape of canned mushrooms about 2,300,000 pounds annually, principally from France. There is no reason why this important food plant should not be grown here to a sufficient extent to cover all our needs. One of the greatest difficulties of mushroom growers, both in this country and in Europe, has been the uncertainty of growing a productive spawn of high vitality, and so far practically only one variety of mushroom has been cultivated commercially. The Department has now discovered a simple and practical method by which we have produced a high grade of spawn, not only of the cultivated mushrooms, but of many of the wild sorts which it is desirable to cultivate. The perfection of a simple and effective method of propagation, as above stated, applicable to all varieties of mushrooms, is probably the most important step in mushroom culture that has ever been made.

DRUG AND MEDICINAL PLANTS.

The extensive importations of crude drugs, amounting to more than $3,000,000 annually, have led to many attempts to cultivate drug plants in this country. In most instances this work, entered into by persons who were without adequate information in regard to the conditions required, has resulted in discouragement and loss. Experiments undertaken by the Botanist to determine the actual cost of producing, curing, and preparing for market certain kinds of crude drugs,

especially leaves of plants like stramonium, indicate that they can not be produced profitably unless they may be grown where land and labor are cheap, and where the growing season is long. An experiment in curing the leaves with artificial heat gave very promising results, and if this method proves to be entirely satisfactory a great saving in time and labor will be accomplished in this part of the work, with the assurance of greater uniformity in the product.

The cultivation of golden seal, seneca snakeroot, and other similar native drug plants that are becoming exterminated in the wild state, has been begun on a small scale, to secure definite knowledge in regard to their life habits and to determine the conditions under which they may be cultivated. Owing to the increasing demand for them and their rapid disappearance from the forests, their successful domestication is extremely desirable.

POISONOUS PLANTS.

The important results from the poisonous-plant investigations conducted by the Botanist in previous years have been followed by an increased demand for further work along this line. The annual loss of sheep from eating poisonous plants on the ranges of the Northwest has been estimated to exceed $400,000. There are also very considerable losses among cattle and horses on the Western ranges, due to death camas, loco weed, and other poisonous plants. Besides a large amount of miscellaneous work in this direction, with the accumulation of important information in regard to various kinds of poisonous plants, special investigations have been made with two important groups—death camas and the lupines.

The excellent lupine forage, which has been avoided by many stockmen because they lacked knowledge of the character of its poisonous properties, may be utilized, providing certain precautions are regarded. Sheep must not be allowed to eat freely of lupines when coming hungry and thirsty from a dry, barren range. Some other food, preferably of a succulent character, and a plentiful supply of water should be given to animals grazing on lupines.

FIBER PLANTS.

The importation of vegetable fibers amounts to more than $30,000,000 annually, and the quantity is continually increasing; yet it is scarcely sufficient to meet the demands of our increasing cordage and textile industries. There are areas in this country where soil and climatic conditions are as well suited to the growth of flax and hemp as anywhere in the world; yet nearly all of the flax fiber and more than half of the hemp fiber used in our manufactures is imported. To compete successfully with the foreign product, our farmers must produce a fiber of equal or superior quality at a relatively low cost. The first requisite for superior quality of fiber is an improved variety of the flax or hemp plant. With this object in view, seeds of improved foreign varieties are being imported, and selections of seed are being made from American-grown plants. Reduction in the cost of producing the fiber must be brought about mainly by the introduction of improved methods of handling the crops and the substitution of machinery for the large amount of skilled hand labor which has here-

tofore been regarded as necessary in the preparation of the fiber. Carefully conducted experiments are needed to demonstrate the practicability of new methods that will reduce the cost of production.

IMPROVEMENT IN MANILA FIBER.

Manila fiber is the strongest and most important material used in the manufacture of the better grades of cordage. With a greatly increased demand during the past five years, and consequent high prices, a tendency arose among Philippine producers of manila fiber to sacrifice quality for quantity. Importations showed carelessness in preparing and in grading the fiber, a condition that threatened serious injury to the market for this, the most important product of the Philippine Islands. After careful examination of the fiber in the bales as imported, a report was forwarded to the Philippine government, by whom immediate action was taken and a thorough investigation made of the production of manila fiber in the field and its preparation for export. A law has been drafted by the Philippine government regulating the methods of cleaning the fiber, and also to provide for inspection of fiber to be exported. The higher standard of quality and the uniformity of grade assured under this law will not only result in great satisfaction to the manufacturers and users of manila cordage, but it will tend to still further increase the market for this most useful fiber.

GRAIN-GRADING METHODS.

The inspection and grading of grain, which is a prominent feature of our grain business, has been the cause of some apparently well-founded dissatisfaction in both our domestic and foreign trade. The chief cause of this has been that grain inspectors have had, as a rule, no adequate means of educating their judgment, upon which they must rely for the greater part of their work, and the inspection departments have had no very satisfactory apparatus for settling disputed or appealed cases. During the past year the Department has developed an apparatus for determining the moisture content of grain, particularly corn. This apparatus, essentially an air bath and a delicate balance, enables any inspector or warehouseman to determine the condition and probable keeping quality of corn; since excessive moisture is the principal cause of deterioration in this cereal.

Methods of accurately measuring essential qualities and defects of any sample of grain are a necessary preliminary to a satisfactory system of grain grading. The Department is, therefore, endeavoring to learn what these essentials are for each class of grain and how they can best be measured, so that grain inspectors may have available the means to do their work with the highest possible degree of efficiency.

The general adoption of such methods is likely to be of great benefit to the grain trade, as it will naturally result in greater definiteness of rules for grades and more uniform work by inspection departments.

FOREIGN COMPARED WITH DOMESTIC CLOVER SEED.

For the past two years cooperative work has been carried on between the Bureau of Plant Industry and several of the agricultural experiment stations to determine the relative value of foreign and domestic

red clover. The seed raised in this country has given a larger yield of hay, though one sample from Russia gives promise of a good yield in the northern tier of States. Experiments will be undertaken to determine the relative feeding values.

TYPE LOCALITIES AND CHANGE OF SEED.

The work done on foreign and domestic clovers shows that there is a marked effect on general thriftiness, yield, and earliness when seed from one locality is sown in another where it is subjected to different conditions of climate and soil. Under the present methods of handling in this country, the seed is all brought together at the large market centers, where it is bulked and graded according to appearance, without regard to place of growth. This seed is then distributed to the small dealers throughout the clover-growing area. While the indiscriminate mixture and change of seed resulting from this method of handling may prove beneficial in some cases, it is often undoubtedly a distinct disadvantage.

The seed of all of our grass and forage plants, as well as much of our vegetable and grain seed, is produced under similar conditions, thus preventing any knowledge of origin or special adaptability.

A thorough study should be made of our principal crops to determine the type or best locality for seed production, as well as the advantage or disadvantage of changing seed from one locality to another, and the limits within which this should be done.

A study should also be made of both the foreign and domestic seed production of the crops, of which we now import large quantities, so that the domestic production may be aided and encouraged as far as possible.

DEMONSTRATION WORK WITH FORAGE CROPS.

The office of Grass and Forage Plant Investigations has put in the field a number of agents, whose duty it is to visit farmers in sections where forage plants are needed and arrange with them to grow a small area of some crop which is known to be valuable in that section. In this way much interest has been created in crops which were new or comparatively so, particularly in the cotton-growing States. As a result of this work, there is now a decided movement toward a diversified system of farming.

In addition to the above, a number of small demonstration farms have been established, on which various grasses and forage plants are grown, under the direct supervision of officers of the Department. These farms are visited by large numbers of farmers who by this means acquire an interest in the crops and some knowledge concerning their cultivation and utilization. In other words, new and valuable crops are being rapidly introduced into many sections of the country where greater diversification of crops is needed.

WILD HAY.

In 1899, 15,457,000 acres of wild grasses were cut for hay in this country. During the present season the grasses thus utilized have been studied with a view to ascertaining their relative agricultural

value. Much important information has been gained, and some of these grasses have been found which possess characteristics that will enable us to bring them into cultivation, particularly in the arid and semiarid regions of the West. We are now gathering considerable seed of four or five of the most important, with a view to introducing them on cultivated land.

LEGUMINOUS CROPS.

One of the most important movements which has occurred in American agriculture is now in progress. It is the general introduction of alfalfa as a hay and pasture crop. During the present season good crops of alfalfa have been grown by our experimenters in almost every State in the Union.

Other leguminous crops are receiving a large share of attention. The Department has secured some seventy-five varieties of soy beans, and has grown them for two seasons with a view to finding varieties adapted to different climatic conditions. Within another year we shall be ready to begin the introduction of a number of the best varieties. Varieties have been found adapted to practically all parts of the country.

The cowpea continues to receive a large share of attention in our demonstration work. We are attempting to add largely to the acreage of this important crop in the cotton States. Varieties have been secured adapted to the Northern States as well.

A number of new legumes have been secured and are being propagated with a view to obtaining seed for introduction work in the near future.

RANGE INVESTIGATIONS.

Fifty-eight square miles of typical range land near Tucson, Ariz., have been put under fence during the year. Careful studies are being carried forward on this area, with a view to determining the result of protecting the now exhausted range from the depredations of stock. In the State of Washington we have demonstrated that the mountain ranges may be restocked with grasses by using seed. Our investigations have also shown that the ranges in that section may be so handled as to largely increase their productive capacity; but in order to do this it is believed to be demonstrated that it is necessary for those who graze stock upon the ranges to control a definite area of range land.

SOIL AND SAND BINDERS.

A representative of the office of Grass and Forage Plant Investigations during the past season studied the extensive work on soil and sand binding that has been done in Europe. After two hundred years of experience in Europe it has been shown that drifting sand can be controlled. Work has been undertaken with this end in view at The Dalles, Oreg.; Astoria, Oreg.; on the eastern shore of Lake Michigan, and at several points on the Atlantic coast. In many places these drifting sands have covered up extensive areas of valuable farm land. In other cases they have encroached upon cities, and have even buried portions of them. In still others they have interfered seriously with railroad traffic.

CASSAVA.

Studies by agents of the Department have shown that the cassava crop is of great importance in the region adjacent to the Gulf as a feed for cattle and hogs. This crop has been grown in a desultory way in Florida for nearly half a century. The value of the crop has been known, but there have been two principal difficulties in the way of its cultivation. The first is that it is propagated from sections of the stalk, and these are very difficult to keep during the winter season. Growers have now been found who have apparently solved this difficulty, and a number of the best methods of keeping the seed stems will be tested on a large scale by the Department this winter.

The other difficulty relates to securing a stand. It has been demonstrated that it is practicable to sprout the cuttings in hotbeds and transplant them into the field afterwards, and in this manner to secure almost a perfect stand, thus doubling the average yield. Arrangements have been made to give this method a thorough trial next season. The importance of this work will be better understood when it is known that an acre of cassava yields as much food value as 8 to 10 acres of corn in the section where cassava is grown.

POMOLOGICAL INVESTIGATIONS.

In no other country in the world has fruit culture attained such large proportions as in the United States. Favored with a broad range of latitude, affording great variety of soil and climatic conditions, there are but few fruits of the temperate zone that are not now produced on a commercial scale within our borders. The track of the pioneer has everywhere been marked by the planting of orchards and vineyards.

In certain regions the production of fruits and their products has become the chief feature of agricultural life, and the welfare of the people therein is largely dependent upon the successful production, harvest, and sale of such fruits as the peach, apple, grape, orange, and several others. In all such regions the question of adaptability of types and varieties to soil and climatic conditions, and their suitability for the purposes for which they are to be used, becomes a most important one from the economic standpoint. Unlike the grower of grain or vegetables, the orchardist or vineyardist must invest years of time and labor, in addition to the original outlay for land and stock for planting, before his plantation attains sufficient age to begin to yield a return. It is therefore of the utmost importance that there should be accessible to him information regarding the distinct characteristics of fruit varieties, their particular requirements as to soils and climate, their times of ripening, and suitability for particular uses, such as shipment to distant markets, use in canning, drying, preserving, etc. One of the important duties of the Pomologist and the force engaged under him, is to accumulate and interpret the results of individual experience along these lines throughout the country, so that it may be furnished to the interested public in convenient form for their guidance in fruit culture.

FRUIT MARKETING AND STORAGE.

Some of the most pressing and important questions relating to the fruit industry are those that grow out of the present tendency in horticulture to produce each fruit in that section where it can be

grown best or to mature at a certain desired time, even though that locality be thousands of miles from the market where the product will be consumed. These problems may be characterized as those relating to marketing and storage. Their solution lies at the foundation of development of important export trade in fruits, and is hardly of less moment in connection with that portion of the crop which is used at home.

Some of the questions involved are with regard to the best methods of harvesting, grading, packing, and transporting each fruit, with reference to accomplishing its safe and economical delivery at its desired destination; also with regard to the suitability of the variety, packing and package, to the needs of the consumers, who are to be the purchasers if profitable trade is to be built up. These questions are of especial importance in connection with the export trade, and a series of experimental shipments is being made to obtain light upon these points.

Through these experiments, which have been conducted on a commercial scale, chiefly through the ordinary channels of trade, it has been demonstrated that the Bartlett pear, a choice but perishable fruit, of which there is frequently so large a surplus in our Eastern States as to depress prices to a point where the producer receives little return for his labor, can be successfully and profitably shipped in refrigeration across the Atlantic and sold at prices that yield a good net advance over home value.

Elberta peaches from Georgia and Connecticut, and several varieties of summer apples from Delaware, can be landed in London in prime condition when the climatic conditions at time of shipment are favorable; and they are likely to meet with good demand at fair prices.

It is gratifying to note that commercial shippers are following the work of the Department along these lines with keen interest, and preparing to make extensive shipments of such fruits as are found capable of profitable handling in this way.

A notable event of the year was the inauguration of direct shipments of American winter apples to Paris through the instrumentality of the Department. As was anticipated from previous investigations made by the Department, russet varieties were found to have preference to red apples in that market, and where sound and free from blemish were in good demand at high prices. The opportunity to develop trade in this line appears excellent.

Numerous and comprehensive tests of other fruits are under way, and may be expected to yield decisive results in due time.

The storage of fruits at low temperatures to retard their ripening and decay for a sufficient time to permit them to be handled to the mutual advantage of the grower and the consumer has assumed very large proportions in this country, chiefly within the past decade. It has been demonstrated beyond question that all fruits destined for preservation in cold storage should be stored quickly after removal from the tree; a uniform temperature of 32° retards the ripening processes of apples, pears, and peaches more than higher temperatures, without any noticeable injurious effect upon their flavor. It has also been demonstrated that certain delicate fruits, like the Bartlett pear and the peach, which ripen in hot weather, require quick cooling after entering the storage room, and that this can probably best be accomplished by storing in small rather than large packages.

STUDIES OF GRAPES AND GRAPE GROWING.

In addition to continuing the work of thoroughly testing the large number of varieties of European table grapes in the cooperative experimental vineyards in North Carolina and Florida, a comprehensive investigation of certain viticultural problems relating to the vine industry of the Pacific coast has been started.

The rapid and extensive development of grape culture in California is one of the most striking features of our fruit industry. Based almost exclusively upon the European grape species, as it is, vineyard methods modeled after those of the Old World are more successful there than in the vineyard regions of the Eastern States, where the native species of grape are the main dependence. The fertile soil and favorable climatic conditions in California have in general resulted in large yields and good profits to the grower.

Certain serious difficulties have arisen, however, which require immediate attention. Among these may be mentioned the general infestation of the important vineyard sections with the destructive Phylloxera, which preys upon the roots of the European grape. The general principles of the method of combating this insect through the use of resistant stocks have been demonstrated by entomologists, but the practical application of these involves many important vineyard problems which properly fall to the viticulturist. Among the most important of these is the relative adaptability of the known resistant stocks to the leading vineyard soil types and the congeniality of the principal commercial varieties of foreign grapes to these resistant stocks.

In cooperation with the California Agricultural Experiment Station and the office of Seed and Plant Introduction of the Bureau, experimental vineyards have been established at Fresno and Oakville in connection with this work.

WORK AT THE ARLINGTON FARM.

APPLES AND PEACHES IN NURSERY.

There are now growing in the nursery some 400 varieties of apples, the scions of which have been secured from bearing trees known to be true to name. The peach list embraces 150 sorts chosen with equal care. These collections have been carefully selected to represent the sorts now commercially grown in the several important apple-growing regions of the United States, together with a carefully chosen collection of varieties which show promise of becoming additions to the commercial list.

The aim of these plantations is that they shall form a basis for the comparative study of varieties when grown under like conditions, in order that the influence of climate on horticultural varieties may be observed, to afford basis for taxonomic studies upon cultivated varieties, and to furnish fresh fruits for comparative studies and identification of varieties, as well as material for further extending physiological studies upon the keeping of fresh fruits in artificial storage.

ORNAMENTAL TREES IN NURSERY.

The nursery at present contains several thousand seedling oaks, ashes, and maples, which have been grown from seeds gathered from trees of note in the District of Columbia. These trees, if sent to

schools, parks, and other outdoor improvement organizations of the country, will prove objects of interest, and will be appreciated because of the sentiment attaching to the place of their origin.

EXPERIMENTAL FRUIT PLANTATION.

A further fruit plantation upon the Arlington Farm, consisting of 1,000 trees, is designed as a basis for studying the physiological action of the various insecticides and fungicides upon the health and longevity of trees.

CRANBERRY PLANTATION.

A small typical cranberry plantation is being established upon the farm, in order to determine the adaptability of the plant to the climate and the lowlands lying along the streams of eastern Virginia and Maryland. There are many thousands of acres of land now lying idle that might be made remunerative by the introduction of this crop if it proves suited to the conditions.

ARBORETUM.

An area of some 30 acres adjacent to the buildings which are in course of construction upon the farm is being prepared as an arboretum, in which will be arranged in an instructive, as well as artistic, manner all the native and exotic trees and shrubs which can be grown here. One of the chief reasons for beginning this line of work upon the Arlington Farm is that in this latitude there is an overlapping of the Northern and Southern floras of the United States, which allows the successful growing of a much greater range of species than can be cultivated either farther north or south.

THE POTOMAC FLATS TESTING GARDEN.

SWEET POTATOES.

An extensive variety collection of sweet potatoes is being grown on the Potomac Flats area. In fact, all of the commercial forms and types of the plant known have been assembled and are being raised, both upon the sandy soil of the flats and upon the clay loam of the Arlington Farm; also at one station in Alabama, one in New York, and three in Ohio, selected to cover the glacial drift soil of Ohio, the glacial drift of New York, and the prairie soil and alluvial river deposit soil of Ohio. The variety collection is designed to afford an opportunity for taxonomic studies, while the growing of the crop upon various soils is intended to give an idea of the influence of soil conditions upon the development and culinary properties of the root.

CELERY.

Celery is receiving special attention. It is being grown under various soil and moisture conditions, from various dates of seed sowing, and under the influence of various commercial fertilizers, in order to learn, if possible, the particular factor in environment which determines pithiness, if it is a question of environment rather than an inherited tendency transmitted by the seed of certain strains and varieties.

EFFECTS OF SHADE ON CROPS.

The physiological effects of shade are so marked and are of such commercial value that the horticultural work of the Department will be extended to cover a test of all truck crops which offer any advantages from being grown in shade. The work of the present season has been largely confined to the use of cloth and slat shades upon celery, cauliflower, lettuce, cucumbers, and radishes. As rapidly as the facilities of the Department will permit, all the truck plants which are grown for leaf production will be submitted to the influence of shade. In connection with this work the atmospheric and soil conditions will be carefully studied, with the hope that the reason why plants behave in a different manner under shade from what they do in the open may be determined.

BEET-SUGAR INDUSTRY.

The beet-sugar industry is developing satisfactorily. In 1896 29,220 tons were made; one year ago 220,000 tons were made. Careful estimates put the crop now being worked up at 260,000 tons. This is a more rapid development than has taken place in sugar making with new conditions in any other country. The future of the crop depends upon the adoption of economic methods in field and factory. The growing of seed in the United States of a superior quality is assured, which will result in much richer beets and better yields than from imported seed that is never first class. Heavier tonnage per acre will come from better farming, and more economy from intelligent disposition of the by-products. The industry is well established.

TEA-CULTURE INVESTIGATIONS.

During the year the work on growing tea has been continued at Summerville, S. C., and a new station has been put in operation at Pierce, Tex. At Summerville further work has been carried on in the testing of new varieties, new machinery, and new factory methods. The work at this point has now reached a state where more attention can be given to the improvement of the teas after being harvested. To this end a number of physiological and chemical studies have been made of the product at different stages with a view to improving methods of curing and increasing the flavors and aromas of the teas. The new methods and apparatus introduced by Dr. Charles U. Shepard, and used in the manufacture of green teas, have proved most satisfactory. Experiments have been carried on quite successfully in the preparation of tea tablets. These tablets are prepared in a special machine of great power, the result being a firm, polished product, which readily falls apart in boiling water. Improvements have been made in the matter of polishing and finishing the teas, all of which will add value to the American product. Despite the fact that the season has been a very unsatisfactory one for a number of reasons, the yield of tea will probably approximate 9,000 pounds, or about what was raised last year. A favorable season would have given a much larger production.

At Pierce, Tex., cooperative arrangements have been made with Mr. A. P. Borden, who has placed at the disposal of the Department a

large tract of land suitable for tea growing, and has arranged to provide buildings and a portion of the labor. The Department has an experienced man located at this station, and is making preparations to put out at least 50 acres of tea the present autumn. It is planned to set out at Pierce at least 100 acres and extend the plantation as the funds permit. The labor question plays an important part in this work, but it is believed that conditions are such in southern Texas that proper labor can be secured without difficulty. Altogether, the tea investigations are in quite a satisfactory condition.

FARM MANAGEMENT.

In my last report I pointed out the work the Department was inaugurating in the matter of farm management. It was there shown that efforts were being made to bring together certain facts relative to the methods of managing farms in certain typical sections of the country, the object being to use this information in improving agricultural conditions where the best processes had not been followed. There is a great deal of valuable work to do in this connection, and there is no question that systematic studies along this line will greatly aid in the advancement of agriculture. In every community and in every section there will be found farmers who are much more successful than others. There are reasons for this, and it is these reasons that the Department is endeavoring to determine, so as to point the way for others to follow along the same successful lines.

Closely associated with this work are the demonstration experiments which the Bureau of Plant Industry is conducting. These have for their object the demonstration of the value of certain crops and certain methods over those which may be in use or existing at the present time. As an example of this kind of work, may be cited what is being accomplished in the introduction of alfalfa and other important forage crops into the South and sections of the country where such crops have not already been grown.

BUREAU OF FORESTRY.

The object for which the Bureau of Forestry exists is first of all to secure the highest permanent usefulness of the forests in the present and future interests of the country. Among our great industries, the lumber industry now stands fourth in importance.

Lumbering of the forests now standing must go on to supply immediate needs. This has made it necessary to find how to make conservative lumbering profitable, and the great danger has been that the rising price and growing scarcity of lumber would not of themselves bring this about until none but inferior forests should be left on which to practice forest management.

It is a safe assertion, that the lumber interests of the United States recognize to-day as never before that forestry has for them a practical commercial value; that the way is in many cases already open to them to consider conservative lumbering as a definite business proposition; and that this condition has been brought about entirely by the efforts of the Bureau of Forestry to deal with the concrete facts of a problem of National importance. The evidence of its success is not only the cases in which lumber companies have already begun to put into operation its plans, prescribing for particular tracts how

to lumber with reference to future production, nor the applications which have been made for similar advice elsewhere, but to the surprising interest in the subject which has lately been evidenced among lumbermen generally.

It is greatly to be hoped that the Bureau of Forestry may not be compelled to let slip this opportunity for an important public service by inability to answer the demands which will be made upon it. Experience has shown its capacity to do this work. The wide knowledge of forest conditions and of methods of operation which it has gathered, and the organization which it has developed, fit it to undertake new problems with a probability of success which can be looked for in no other quarter. In so vast a country as ours, and under forest and economic conditions of such variety, the task of revolutionizing the long-established methods of an industry like the lumber business is one of enormous difficulty. On the ability of the Bureau of Forestry to demonstrate, as fast as opportunity permits, that it is good business for lumbermen to conduct operations with reference to future crops, depends in large measure the success or failure of the attempt to preserve what should be our chief sources of timber supply. The proper equipment of the Bureau for this work is nothing less than a National duty, and I have recommended that the annual appropriation for its use be substantially increased.

ADVANTAGES OF COOPERATION WITH PRIVATE OWNERS.

In cooperating with private owners the Bureau is not expending public money to benefit private interests. Scientific forestry—that is, enlightened management based on an accurate forecast of what a forest can be made to produce in the future—is impossible without full knowledge of all the forces, natural and artificial, which affect its productiveness. This involves a careful study of lumbering methods on the one hand and of the forest itself on the other. The Bureau has now in its possession as the result of this cooperative work the tabulated results of studies in many States from Maine to California and from Florida to Washington, representing a total of recorded individual measurements in the forest, the number of which would mount to scores of millions.

This vast mass of material has been gathered mainly at the private expense of the owners, who have received the expert assistance of the Bureau. Its possession makes it possible continually to enlarge the field of forestry. It has been secured by making its accumulation go hand in hand with practical results. Every working plan prepared and put in operation has meant both the preservation of a source of National wealth and an addition to the knowledge necessary for the wise use of the public as well as the private forests of the land.

Two considerations must be urged in connection with present conditions. The first is that cooperation is now supplying the Bureau with what it needs for Government work at a less cost than would be required to secure the same result independently. The second is that the speedy introduction of management on private lands is a matter of pressing importance. Forest preservation is necessary in the interest of the public welfare. Forest destruction on a large scale is now in progress. It can be checked only by showing that it is possible to use the forests without destroying them. The Bureau of

Forestry is doing this, and there is no other agency which can do it. If the Bureau does not put forth every endeavor to introduce conservative management among private owners, the public interest will suffer.

While it is true that hitherto virtually everything that has been done in this country to introduce conservative management as a paying business has been done by the Bureau, it is far from my wish that the Bureau should continue to control operations for private owners any longer than there is a clear and imperative need. It has already entered on the policy of detaching from its staff competent men to take charge of private operations when called upon to do so, in spite of the fact that it needs the services in its own work of all the trained foresters it has as yet been able to secure. The Government service, however, is the natural goal toward which most ambitious students of forestry will strive because of the superior opportunities of training which it affords.

SCIENTIFIC INVESTIGATION OF FOREST PROBLEMS.

There is danger that the attention which the work of the Bureau in promoting the actual management of forests naturally receives may obscure the importance of the investigations which it is conducting along other lines. These investigations are largely scientific in scope and method, but always entirely practical in purpose and outcome. The Bureau is the recognized source of information for the country on all forest subjects. The volume of its great and growing correspondence due to this is one evidence of its usefulness. It is conducting experiments along lines which have received the enthusiastic approval of engineers, constructors, and the like, to determine the strength of timbers. It is discovering how to treat cheap woods with preservatives so as to make it commercially practicable to substitute them for more expensive kinds, thus virtually adding new sources of valuable supply. It has inaugurated a new method of gathering crude turpentine which has revolutionized within a single year the naval stores industry of the United States, with an annual output of $13,000,000 worth of turpentine and rosin, whereby the yield of turpentine is nearly doubled with practically the same expense for labor, and the life of the tree which yields the turpentine is greatly prolonged.

In the fall of 1902 this new system had been experimentally in commercial use for a single season on the tract of one operator in Georgia. To-day the men who conduct three-fourths of the operations in the whole Southern pine belt have adopted it, or are waiting to adopt it as soon as their orders for the necessary apparatus can be filled.

FOREST MANAGEMENT.

While the growing willingness of the private owners, in whose hands are the great bulk of the forests of the country, to inquire into the possibilities of forestry in connection with their holdings has opened an opportunity for educational work, the value of which it is hardly possible to overstate, a larger proportion of the energies of the Bureau has been given during the past year to introducing forestry on public lands than ever before.

In accordance with the provisions of the so-called Morris bill, selection has been made and approved of 104,159 acres out of a total of 225,000 acres of land in the Chippewa Indian reservations in northern Minnesota, which will constitute the Minnesota National Forest Reserve. Official announcement of the second selection will soon be made. Selection of ten sections to be reserved from sale and settlement has also been made and approved. Volume tables and estimates of the total stand of the forest have been prepared, upon which will be based recommendations for the reservation from lumbering of 5 per cent of the timber for seed trees, as the act provides. Trees which will not be cut when the forest is lumbered have been marked on more than 6,000 acres, and rules which will control the lumbering have been prepared and have been approved by the Secretary of the Interior.

A working plan for the tract of the United States Military Academy at West Point was prepared at the request of the Secretary of War. The forest, which consists of hardwood sprouts, is in poor condition, the result of numerous fires and injudicious cutting. The plan is accompanied by forest maps, which show the location and area of the various types of forest, and provides for fire protection and for such improvement cuttings as will again put the forest in a sound and healthy condition. This plan is now being put into effect under the supervision of the Bureau of Forestry.

At the request of the Secretary of the Interior working plans were prepared for three Indian reservations in Wisconsin, which include recommendations for their protection from fire and rules under which they shall be lumbered without unnecessary damage to the forest.

ADVICE FOR PRIVATE OWNERS.

Ninety-four applications for assistance in managing forest lands were made by private owners. Of these applications 37 were for timber tracts and 57 for wood lots. Since the Bureau put into effect its cooperative scheme of assisting private owners, applications have been received for advice in the management of 5,656,171 acres. Farmers and other private owners of small tracts of woodland throughout the Northeast, the Middle West, and the South Atlantic States have applied in increasing numbers for the assistance of the Bureau in the management of their tracts. Fifty-eight working plans for wood lots were prepared last year.

STUDIES AND WORKING PLANS.

Field studies of five large timber tracts were made as follows: On 39,000 acres in Berkeley County, S. C.; on 2,321 acres on the Susquehanna River above Harrisburg, Pa.; on 16,000 acres in Mitchell, Caldwell, and Watauga counties, N. C.; on a Longleaf Pine forest in southeastern Texas, involving field work on 300,000 acres, which occupied 35 men for four months; and on 125,000 acres in northwestern Maine, which occupied 32 men for three and a half months.

Working plans are in preparation for the following tracts: A forest of 25,000 acres in Sullivan County, N. H.; a forest of 50,000 acres in West Virginia; and a forest of 3,000 acres in Grafton County, N. H.

The forest of R. C. Neal, near Harrisburg, Pa., for which a working plan was prepared last year, is now under conservative forest management. Two field assistants of the Bureau are supervising the lumbering operations of a large company in Newton and Jasper counties,

Tex. The working plan for the United States Military Academy at West Point is now in operation. Twenty-seven wood lots in the Northeast and South Atlantic States are being managed in accordance with the recommendations of the Bureau. The first selection of the Minnesota National Forest Reserve, consisting of 104,459 acres, is now under the Bureau's supervision. In addition to these lands, 679,194 acres of private lands and 106,759 acres of public lands not included in forest reserves are under forest management.

The interest which large railroad companies have recently exhibited in the practice of forestry is one of the most encouraging developments of the year. Many of them have made application to the Bureau for its cooperation in studies whose results would determine the advisability of the purchase and management of forest lands for the production of railroad ties and other timbers. Forest work for railroads offers very great opportunities for useful work.

Cooperative studies of State forest conditions, in which the States shared in the expense of the work, were made for Maine, New Hampshire, and California. In Maine the forests of Piscataquis County, south of Moosehead Lake, were studied. The results of the work were presented in the Fourth Report of the Forest Commissioner of that State. In New Hampshire a study of the forests of the entire State was begun, with the purpose of determining the methods by which they may best be preserved. In California the work was directed toward the making of a forest map of the State, the determination of practical modifications in lumbering methods, and of the effects of grazing and fire, and other matters entering into the determination of a State forest policy.

Studies were made of the Sugar Pine in California, the Lodgepole Pine in Montana, commercial hard woods in West Virginia, North Carolina, Tennessee, and Kentucky, the Balsam in the Adirondacks, the Chestnut in southern Maryland, and the Red Pine in northern Minnesota.

The section of Forest Measurements, without increase of force, accomplished nearly twice as much work as in the previous year.

WORK FOR THE COMING YEAR.

The work of the section of Forest Management for the ensuing year includes more important undertakings than ever before. Technical problems involved in the management of the National forest reserves must be solved; the field work in Texas, in South Carolina, and in Alabama must be completed. Much work remains to be done on wood lots for private owners. On the lands to be included in the Minnesota National Forest Reserve those trees must be marked which are to be reserved in the lumbering, and supervision of the lumbering operations must be exercised by the Bureau. The study of the forests of California and of New Hampshire remains to be completed, and a study of Vermont forests will be undertaken. Commercial tree studies will be made in Maine, Minnesota, and the Southern States.

FOREST INVESTIGATION.

A notable accomplishment in the South during the year has been the extensive introduction of the cup and gutter system of extracting turpentine. This system, invented by Dr. Charles H. Herty, working

under the Bureau's direction, although in operation only a year, is rapidly replacing the old, destructive system of boxing trees. Its great superiority is due to the fact that it is far less destructive than the box and that it yields at least 40 per cent more turpentine.

INVESTIGATIONS IN 1903.

Forest investigations were carried on in the following States:

In Maryland, a study of the distribution of the forests of St. Mary, Prince George, and Kent counties, in cooperation with the State Geological Survey.

In Texas, a study of the forest growth of the Edwards Plateau and its influence on stream flow.

In Missouri, a study of the swamp forests, including such timbers as Bald Cypress, and Red, Black, and Cotton gums.

In California, a study of the Tan-bark Oak in connection with the tan-bark industry.

In Ohio, Iowa, Michigan, and Montana, a study of forest distribution.

An investigation of the cedar-shingle industry was carried on in the Pacific Northwest, which included a study of the supplies of shingle cedar, the rate of consumption, etc.

The dendro-chemical laboratory, which was conducted in cooperation with the Bureau of Chemistry, obtained much valuable information in its study of gums and resins, the production of tannins, the use of different woods for pulp manufacture, the effects of poisonous chemicals on the life of trees, and the detection of adulterants in turpentine.

The life history of various insects harmful to trees in the East, South, and West was studied by the division of Forest Entomology in cooperation with the Bureau. It has been estimated that insects destroy every year $100,000,000 worth of timber. Experiments were carried on in methods of lessening this great damage.

Studies were made of the basket-willow industry and of the maple-sugar industry, and bulletins on both subjects are now in preparation.

WORK IN PROSPECT.

Work in forest investigations for the ensuing year will include—

Bulletins containing descriptions of the trees of the Northeastern, Southeastern, Rocky Mountain, Southwestern, and Pacific slope regions.

An attempt to clear up the confusion in the common names of trees.

A study of forest distribution in two counties of Maryland.

Special studies of forest distribution in Missouri and Arkansas.

A study of the Big Tree of California; of the acacias of the Southwest; and of the uses, structure, and characteristics of various American timbers.

Further experiments in turpentine orcharding under the cup and gutter system, to determine the minimum wound which it is necessary to inflict on the tree, the forest conditions which make for the highest productiveness, and the like.

A forest exhibit at the World's Fair, St. Louis.

FOREST EXTENSION.

Plans for tree planting were made for 68 applicants in 29 States. These plans, which involved the examination of 40,557 acres of land, were made in accordance with the cooperative plan inaugurated by the Bureau. Most of the plans were for farm wood lots of not more than 10 to 20 acres, but there were several notable exceptions. A plan was prepared for 108 acres on the Presidio Military Reservation of San Francisco. Planting plans were prepared for the grounds of the State institutions of North Dakota, at the request of Governor White. Other plans were prepared for farmers in the prairie regions along the Fort Worth and Denver City Railroad at the request of that company, and more than 600,000 trees were set out.

A planting plan was prepared for 640 acres in Cullman County, Ala., formerly covered by Longleaf and Shortleaf Pine. It was recommended that Loblolly Pine and White Oak, Post Oak, and Chestnut be planted on the land.

Men applying for planting plans show everywhere a disposition to follow the recommendations of the Bureau. Planting plans previously made are being carried out with encouraging prospects of success.

Tree planting continues on the Dismal River Forest Reserve of Nebraska and the San Gabriel Forest Reserve of California. The boundaries of the Dismal River Reserve have been surveyed and marked. Eighty acres of bottom land adjoining the reserve have been fenced, and part of the land converted into a tree nursery with space for the growing of 2,000,000 plants. Many thousands of Western Yellow Pine and Jack Pine seedlings were collected in the Black Hills and in Minnesota for planting in the Dismal River Reserve. On the San Gabriel Reserve much experimental planting was done on widely scattered areas. The planting was done mostly with pine seeds in seed spots. The total cost averaged $7.41 per acre.

The natural reproduction of deficient forests has been studied among the hardwoods of Oklahoma, the Western Yellow Pine on the Prescott Reserve of Arizona, and the White Pine on the abandoned fields and pastures of New England.

A very important branch of the Bureau's work is the study of forest fires, with a view to discovering practicable means of reducing the immense losses due to this cause. The year covered by the present report was characterized by fires of extraordinary severity both in the East and in the West. The investigation of those which occurred in the East in the spring and early summer of 1903, however, was not begun in time to fall within the scope of the present report. The great forest fires of September, 1902, in Washington and Oregon were the subject of a special investigation by the Bureau, which discovered a total loss estimated at $12,767,100. The Bureau's investigation showed that most of the destruction was due to carelessness and might easily have been avoided. Forest fires were studied also in Georgia, Florida, and the Lake States, with a view to discovering their causes, methods of prevention, and the total amount of damage they do.

Examinations of the Atlantic Coast and Columbia River sand dunes were made in order that methods of tree planting might be discovered to restrain the encroachments of the shifting sands. Tree-planting plans for sand-dune regions on the Atlantic coast are in prep-

aration, and a strip of sand-dune land in Oregon has been withdrawn for experiment.

Work for the ensuing year will include:

A continuation of cooperative work in tree planting among private owners.

Tree planting on Pikes Peak, Wichita, Prescott, and San Bernardino forest reserves.

Improvement of natural reproduction on Pikes Peak Reserve and on lands in northern New Mexico.

Extension of the timber belts of Kansas.

A study of the methods of restocking cut-over pine lands in southern Michigan.

A continuation of the study of second-growth White Pine in New England.

A cooperative study with the State of California in improving the stands of timber.

A study of the Eucalypts.

The suppression of forest fires and the reclamation of shifting sands will continue to receive the attention of the Bureau.

FOREST PRODUCTS.

A work of great scope and importance undertaken by the Bureau is the determination of the strength and durability of the merchantable timbers of the United States. The investigation consists of tests of timbers performed in cooperation with the Bureau of Chemistry. The work is directed toward the solution of practical problems of interest to engineers, and has been approved by many prominent engineers, manufacturers, and lumbermen. These tests are being conducted in laboratories at Washington, New Haven, Conn., and Berkeley, Cal., on Red Fir, Western Hemlock, and Longleaf and Loblolly Pine.

Wood preservation forms a most valuable feature of the work of the Bureau. Railroad companies have eagerly followed the results of this work, since it has so important a bearing on their interests. The work consists in experiments in methods of seasoning and preserving construction, railroad, and other timbers so as to increase their strength and their lasting powers. A special feature of the work which gives great promise of success is the experiments with cheap substitutes for valuable woods used for railroad ties. Such work has been done with the Lodgepole Pine in Montana, with gums, birches, and inferior oaks in Pennsylvania, Kentucky, Arkansas, and Mississippi, and with Loblolly and Shortleaf Pine in Texas. Methods of seasoning Chestnut poles were studies in cooperation with the American Telegraph and Telephone Company.

Examinations and reports dealing with technical problems in the management of forest reserves have been made for reserves in Utah, California, Oregon, and New Mexico. Twenty-nine agents of the Bureau this summer examined more than 20,000,000 acres proposed as forest reserves in the Rocky Mountain and Pacific coast States.

FORESTRY RECORDS.

Extensive improvements have been made in the equipment of the forest library. Many books, pamphlets, and clippings have been

added, and the whole library has been completely classified and indexed. The collection of photographs has been increased by 3,417 views, taken in 41 States and Territories and in many foreign countries. The mailing list of the Bureau has increased by 75 per cent. Eighteen new publications were sent out, of which 237,000 copies were printed. Besides these, 23 press bulletins and reprints of 14 publications were issued.

BUREAU OF CHEMISTRY.

NEW INVESTIGATIONS.

EFFECT OF PRESERVATIVES AND COLORING MATTER UPON HEALTH.

As numerous experts of high character have declared both for and against the wholesomeness of many common food preservatives, and as the law authorizes the Secretary of the Treasury to exclude from the country food products to which any injurious substance has been added, the necessity for an investigation of these differences of opinion and the establishment of a wise and just conclusion in regard to them is apparent. To this end, as well as for the information of the public, an elaborate series of experiments has been inaugurated. It is evident, in view of the work previously done in this line, that neither mere theorizing on the chemical and physical properties of preservatives and coloring matter nor experiments upon other animals than man can lead to definite results. With this in mind an experiment was developed as follows:

Twelve young men, who responded to a request for volunteers, pledged themselves to use no other food or drink than that provided for them, with the exception of water, any water not used at the table to be measured and reported daily; to continue to be for at least six months members of the "hygienic table," and during this time to observe implicitly all rules as to diet, exercise, smoking, etc., laid down for them by the Chemist.

A period of rest was effected by placing six of the men at the observation table and the other six at the recreation table alternately throughout the period of seven months. Each experimental period varied from thirty to forty days, and was divided into a "fore period" of ten days, during which a standard ration for each man was determined; a "middle period" of from ten to fifteen days, during which time each member ate the ration previously determined, together with the added preservatives, which in this experiment were borax and boracic acid; and an "after period" in which the same ration was continued, but the preservative withdrawn, the object being to restore the body to its normal weight in case it had been disturbed by the preservative.

A daily record was made on blanks furnished each member of the table of the following data: Weight, pulse, temperature, all data connected with the income and outgo of the food, and an account of all the foods taken and the meals at which they were eaten.

By analysis it was possible to determine just what part of the food was consumed in the production of heat and energy within the system, provided the weight remained constant. Furthermore, any failure on the part of the individual to observe the pledge to partake of no food or drink except what was served at the hygienic table would have been at once disclosed by a disturbance of the balance sheet.

Such in brief was the nature of the experiment conducted. The mass of analytical data obtained is now in the hands of the calculators, and these data, together with such conclusions as an unprejudiced judgment would approve, will shortly be published. The recording of the facts as they occurred and the tabulation of the figures in the most scientific manner possible will present to experts a basis for conclusions. The experiment is to be continued, taking up the most important preservatives in turn, salicylic acid being the next to be considered.

INSPECTION OF IMPORTED FOODS.

Looking to the enforcement of the pure-food law, enacted March 3, 1903, and going into effect July 1 following, preliminary arrangements were made with the Secretary of the Treasury and the Secretary of State by which their active cooperation was secured. The Secretary of State issued directions to the United States consuls that special declarations concerning imported foods be made and forwarded to the Secretary of Agriculture, and through the Treasury Department the collectors of customs at the leading ports in the United States were instructed as to the steps necessary to be taken in sampling such cargoes as might be detained for examination and the reshipping or destruction of such shipments as might, upon analysis, be excluded from the country under the terms of the act.

TABLE SIRUP FROM ORDINARY SUGAR-PRODUCING PLANTS.

The investigations previously made in the Division of Chemistry, and the testimony submitted before the committees of the House and Senate charged with the investigation of the adulteration of food products, show that table sirups are generally adulterated in a degree corresponding to the price paid for them. Glucose is the material commonly used for the basis of this product. In this way the price of the genuine articles has been depressed to a point which renders their profitable production problematic. To combat this condition an investigation has been instituted to study the methods in vogue for the manufacture of table sirups, to ascertain how the product can be improved, and to conduct experimental work in the growing and fertilizing of sugar cane to determine methods for securing the highest financial returns. An elaborate fertilizer experiment was conducted on the farm of Mr. W. B. Roddenbery, at Cairo, Ga., from which practical results of a valuable nature were obtained and reported in Bulletin No. 75, Bureau of Chemistry.

The manufacturing data, obtained largely at the factory of J. T. Wells, Guyton, Ga., will be published in a separate bulletin when the additional experimental factory work now going on at Waycross, Ga., is completed.

COLLABORATIVE WORK WITH EXECUTIVE DEPARTMENTS.

The collaboration authorized by Congress between the Bureau of Chemistry and such departments of the Government as may apply to the Secretary of Agriculture for chemical analyses has extended until it includes almost every branch of the service, the most extensive work having been conducted in connection with the Treasury Department. This collaboration included the sugar tests made on samples received daily from the appraisers' laboratories at New York, Boston, and Philadelphia, which comparative tests, extending as they have over a

period of three years, have been productive of the most useful results in eliminating wide differences existing in the polarizations made at the ports named.

Other examinations made for the Treasury Department include an investigation of the percentage of ethyl alcohol in certain fusel oils imported into the country; an examination of the natural content of sugar in pineapples imported from different parts of the world; and the analysis of samples of ice and water intended for drinking purposes in the Bureau of Engraving and Printing.

Examples of cooperative work with other Departments are examinations of coal for the National Hospital for the Insane, at Washington, D. C., and paper for the Geological Survey, made at the request of the Secretary of the Interior; the examination of beverages offered for sale in Indian Territory, made on the request of the Attorney-General; samples of glue offered on competitive bids to the Government Printing Office; and a large amount of miscellaneous work for the Post-Office Department, including examinations of paper, ink, and stamps.

It is evident that work of this character, and especially such part of it as relates to the awarding of contracts, gains in uniformity and authority by emanating from one laboratory, and at the same time is more economically performed. The appreciation of this fact is seen in the constantly increasing number of requests received from other Departments for such work.

WORK OF THE LABORATORIES.

THE FOOD LABORATORY.

Upon this laboratory has devolved the greater part of the analytical work necessitated by the experiments with food preservatives, involving the examination of 5,500 samples, as well as all cooperative work on foods, such as pineapples, and the fermented beverage and fusel oil investigations. In addition, an exhaustive study of olive oil and its adulterations has been completed; a study of the composition of apples with special reference to changes in composition during ripening under different methods of cold storage has been continued in collaboration with the Pomologist of the Department; and 134 samples of fruit sirups and nonalcoholic beverages were secured in the open market and analyzed. The grape juices show a great improvement in the methods of preservation since the study made of them several years ago.

As heretofore, important work has been done in this laboratory in connection with the Association of Official Agricultural Chemists and the food chemists throughout the country in the investigation and comparison of methods for the analysis of foods. Two members of the staff have also done considerable work as associate referees on sugar for this association.

During the year a compilation of the pure-food laws of the various States was issued in five parts.

INSECTICIDE AND AGRICULTURAL WATER LABORATORY.

About 1,500 analyses were made in this laboratory, including the following lines of investigation: Mineral and irrigation waters; sanitary examinations of water; insecticides; the arsenic content of wall papers, furs, etc.; cattle foods; and toxicological examinations to determine whether bees are killed by poisons used in spraying. Most of

these results, bearing directly as they do upon public health, either have been or will be reported in bulletin form. A portion of this work is performed in cooperation with the office of irrigation investigations and the Division of Entomology. Considerable work on methods of analysis for insecticides has been done by the chief of the laboratory as referee in the Association of Official Agricultural Chemists.

THE SUGAR LABORATORY.

In this laboratory the work on sugars for the Treasury Department was performed under the supervision of the Chief of Bureau. All analyses in connection with the cooperative experiments on sugar-producing plants (beets, sugar cane, and muskmelons) which have been conducted for several years in collaboration with various experiment stations are also made in the sugar laboratory. The total number of analyses reported was 1,744.

THE DAIRY LABORATORY.

Of the 1,056 analyses made in this laboratory, 807 were reported to the dairy division of the Bureau of Animal Industry, for which Bureau the chief of the laboratory served twice as a witness in a renovated butter case tried in New York State. The difficulty of distinguishing between butter produced by feeding cotton seed or cotton-seed meal and that to which foreign fats have been added, presented itself, and will receive special study during the coming year.

THE CONTRACTS LABORATORY.

The work performed in this laboratory included a large part of that referred to under collaborative work, and consisted mainly in the examination of samples submitted with bids for contracts to different branches of the Government, and in the development of qualitative and quantitative methods for the analysis of the same. Especially exhaustive examinations were made of khaki cloth for the Navy Department and 60 samples of ink for the Post-Office Department, a set of methods being determined in the progress of the latter work which were published as Circular 12, Bureau of Chemistry. Sample inks, prepared according to recipes developed in the laboratory, were sent to the Post-Office Department to be tested, and a set of standards established whereby to judge of an unknown ink.

THE ROAD-MATERIAL LABORATORY.

While the work of this laboratory has continued along the same general lines as in the past, its usefulness has been greatly extended, especially by the increase of its force.

The work of the chemist in charge included an investigation of the cause of the cementing power of rock dust, gravels, and clays, which involved many complete analyses and resulted satisfactorily. Other researches of immediate practical value have included a series of experiments on the burning and clinkering of clays, with a view to their use as road materials, and a study of the possibilities of increasing the binding power of materials by artificial means. During the coming year it is hoped that a thorough, practical test of burnt clays for country highways may be completed, as there are vast areas throughout our country where this is the only road material available, and the determination of the quality of clay adapted to this purpose would solve a great problem in road building.

Another important problem being studied in connection with such localities involves an elaborate series of experiments with mixtures of crude petroleum and asphaltum. The object of these experiments is to provide a binder surface for country roads which will place what would be practically an asphalt road within the reach of all rural districts, the cost of this mixture and its application being less than that of watering a macadam road.

Two new tests for determining the hardness and toughness of rock are to be adopted and reported on all routine samples, which it is believed will be of great assistance to road builders. These tests represent a new field of investigation and the machines for making them have been designed and are now in operation.

Other questions to receive special consideration are the testing of cement and concrete for road foundations, drains, and highway bridges, and tests on paving brick. The general testing of rock for macadam roads will be continued.

A bulletin on the testing of road materials, giving a detailed account of the methods employed and the results obtained in this laboratory, is now in press.

THE DRUG LABORATORY.

This laboratory went into operation on March 1, 1903, and has already reported on 120 samples of drugs and chemicals. The work so far done on representative samples of drugs shows that some of these articles are of a very unsatisfactory character. A bulletin entitled Adulterated Drugs and Chemicals is about to be issued.

BUREAU OF SOILS.

PROGRESS AND COST OF THE SOIL SURVEY.

The work in which the Bureau of Soils is engaged forms an important link in the chain of duties devolving on the Department. It is fundamental in character, and as the survey and classification of the soil progresses the results are being more and more made use of by other offices of the Department, as well as by outside investigators and by our citizens.

Up to this time the distribution of the surveys has been influenced by the desire to gain as wide a knowledge as possible of the soils used in the most important agricultural industries of the country, and in this way the work has been scattered through all parts of the country. Thus studies have been made of Eastern and Western fruit districts, of sugar-beet lands, of the cotton and rice lands of the South, of the corn lands of the Central West, and the wheat lands of the Northwest and the Pacific coast, and of the soils of all the important tobacco districts.

One important purpose of the work is to provide data for the comparative study of more or less widely separated areas devoted to the cultivation of similar products, with a view to carrying the better practices of one area to the other, and of suggesting improvements in the methods used and changes in the kind of crops grown. It is one purpose of the work to show where old industries can be extended or new ones established, while the value of the reports and maps to those wishing to purchase lands for any specific purpose is too evident to need emphasis.

The statistics collected by the Bureau will be particularly important in the carrying on of immigration and colonization enterprises.

The area surveyed and mapped during the fiscal year was 23,293 square miles, or 14,907,520 acres, an area just about equal to the total area previously surveyed since the beginning of the work, four years ago.

This enlarged work has been accomplished in part by the organization of five new field parties on the 1st of March, made possible by increased appropriations by Congress, and partly by keeping the parties continuously in the field, moving to Southern areas in the winter. While considerable time was lost in some of the areas by reason of excessive rains, upon the whole this plan has worked well and has materially reduced the cost per square mile. The work has been carried on during the year in 63 areas in 34 States and Territories, as shown in the following tables:

Areas surveyed and mapped during fiscal year ended June 30, 1903, and the areas previously reported.

State or Territory.	Work during 1903.	Work previously reported.	Total.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
Alabama	1,223	.....	1,223	782,720
Arizona	108	503	611	391,040
Arkansas	251	.....	251	160,640
California	1,959	1,962	3,921	2,509,440
Colorado	1,195	150	1,345	860,800
Connecticut	273	245	518	331,520
Florida	548	.....	548	350,720
Georgia	186	571	757	484,480
Idaho	678	399	1,077	689,280
Illinois	2,241	1,356	3,592	2,298,880
Indiana	387	.....	387	247,680
Iowa	576	440	1,016	650,240
Kansas	.....	464	464	297,600
Kentucky	507	330	837	535,680
Louisiana	740	202	942	602,880
Maryland	487	2,147	2,634	1,685,760
Massachusetts	267	143	410	262,400
Michigan	30	828	858	549,120
Minnesota	233	.....	233	149,120
Mississippi	661	656	1,317	842,880
Missouri	751	168	919	588,160
Montana	.....	107	107	68,480
New Jersey	395	908	1,303	833,920
New Mexico	.....	129	129	82,560
New York	1,075	483	1,558	997,120
North Carolina	1,221	3,425	4,646	2,973,440
North Dakota	856	.....	856	547,840
Ohio	375	980	1,355	867,200
Oregon	386	.....	386	247,040
Pennsylvania	266	938	1,204	770,560
Porto Rico	.....	330	330	211,200
South Carolina	1,346	686	2,032	1,300,480
South Dakota	485	.....	485	310,400
Tennessee	.....	547	547	350,080
Texas	1,238	495	1,733	1,109,120
Utah	200	794	994	636,160
Virginia	1,143	1,604	2,747	1,758,080
Washington	51	459	510	326,400
Wisconsin	955	.....	955	611,200
Total	23,293	22,445	45,738	29,272,320

Cost of survey.

Cost of field work	$51,136.60
Supplies	1,901.59
Traveling expenses between areas	5,215.76
Other expenses	5,059.56
Total cost of soil survey	63,313.51
Paid by State organizations	1,748.35
Paid by Department of Agriculture	61,565.16
Area surveyed.....square miles..	23,299
Cost of work in field per square mile	$2.19
Transportation, supplies, and other expenses per square mile	$0.52
Total cost per square mile	$2.71
Cost to Department of Agriculture per square mile	$2.63

The cost of work in the field has increased from $1.83 per square mile, as reported last year, to $2.19 per square mile. This is due in part to increased salaries, necessitated by the fuller experience of the principal assistants, and in part to a large amount of rainy weather in the winter, which raised the cost in some of the Southern areas very considerably above the average.

On the other hand, the advantage of keeping the men out, in spite of the delays from the winter rains, is seen in the reduced cost per square mile where all expenses chargeable to the soil-survey work are included. Last year the average cost to the Department of Agriculture was $2.81 per square mile, and this year the total cost is $2.63 per square mile. It is probable that this is the lowest cost that can be reached, and from now on the cost may gradually increase somewhat, owing to the increased salaries which it may be necessary to pay to hold experienced men in the service.

There has been a great demand for our men from colleges and experiment stations and in private enterprises, but it has been the desire of the Department to keep the men at least five years in the soil survey, after which it is believed they will have had as much experience as they can get from such service, and they should then be prepared to take up special lines of investigation, or be ready to enter into positions of responsibility in educational institutions where soil investigations are being built up.

Although a total of $61,565.16 was spent by the Department for the soil-survey work and $1,748.35 by State organizations cooperating, and 63 areas were surveyed and mapped, with an average of 369 square miles each, we were unable to reach more than half of the areas in which surveys have been requested, and we have on file requests for nearly two years' work with the number of parties available with our present appropriations.

PUBLICATION OF THE REPORT ON FIELD OPERATIONS.

In my last report I called attention to the urgent need—if the full benefit of the soil-survey work is to be secured—of a change in the manner of publishing and distributing the reports on the soil surveys. As the law now stands, in the joint resolution approved February 23, 1901, the manuscript of these reports has to be submitted to the Public Printer all at one time, and the reports must be issued as one volume,

with the maps in an accompanying portfolio. The Senate and House of Representatives together have 9,000 copies and the Department has 8,000 copies for distribution. This gives each Representative about 16 and each Senator about 32 copies—about enough for the public libraries and institutions in their respective States. In addition the Department has usually ordered from 500 to 1,000 reprints of the report on each separate area, and has distributed these as far as they would go in the districts to which the work pertains. Besides being entirely inadequate to fill Congressional needs, this manner of publication has the disadvantage of not enabling the Department to meet the local demands.

One of the chief values of this work lies in the suggestions it affords to the owners of land in the area in directing their attention to new crops and to better methods of agriculture. The bound copies that go to libraries, public institutions, and prominent citizens are very good as works of reference; but for the utmost good to come of the soil survey, copies of the separate reports and soil maps should be placed in the hands of a considerable number of people within the area surveyed, and our experience in the past has shown that there are from 500 to several thousand requests of this kind that the Department has not been able to meet. I would therefore recommend to Congress that, in addition to the bound volumes already authorized, there be printed in the form of advance sheets, as soon as the manuscript, maps, and illustrations can be prepared, a separate report on each area surveyed as completed, of which 500 copies shall be for the use of each Senator from the State, 2,000 copies for the use of the Representative for the Congressional district in which the survey lies, and 1,000 copies for the use of the Department of Agriculture. The reports could in this way be sent out from six to twelve months earlier than is now possible, and could be distributed while the matter is still fresh in the minds of the people who have watched the progress of the field work. It would also be practicable in this way to supply the local demand, a thing quite impossible under the present plan.

ALKALI RECLAMATION.

During the past year the Bureau of Soils has been engaged in making alkali reclamation demonstrations in several parts of the arid West. One such experiment is located near Salt Lake City, Utah, where there is an area of about 120 square miles (75,000 acres) of land unproductive because of excess of alkali. A tract of 40 acres, typical of this waste land, was secured in the summer of 1902 for the purpose of experiment, and the work of reclamation, which is being done in cooperation with the Utah Experiment Station and the owner of the land, has progressed rapidly and satisfactorily.

At the time of beginning the work on this tract it contained a little more than 2½ per cent of salt, or a total of 6,650 tons of salt in the soil to a depth of 4 feet. At the present time there has been removed from this tract, by the simple method of underdrainage and flooding, two-thirds of this quantity.

The following table gives the quantity of water added to the 40-acre tract and the amount of salt added in the irrigation water. The period covered extends from September 1, 1902, to September 1, 1903.

Total quantity of water used in flooding and amount of salt added from this source in the experiment at Salt Lake.

Date.	Water added.	Source of water.	Salt added.
1902.	*Cubic feet.*		*Pounds.*
September	284,400	Canal	24,000
October	940,000	do	83,900
November	171,300	Rain	
December	166,500	do	
1903.			
January	291,800	Rain	
February	136,400	do	
March	132,000	do	
April	112,000	do	
May	576,900	do	79,000
Do	760,900	Canal	
June	106,000	Rain	70,700
Do	676,500	Canal	
July	36,588	Rain	169,190
Do	1,691,966	Canal	
August	2,122,157	do	212,000
Total	8,305,411		638,790

The following table shows the drainage from the tract from September 1, 1902, to September 1, 1903, and the quantity of salt removed in the drainage water during that period:

Total quantity of water carried off through the drains and the quantity of salt removed in this way in the experiment at Salt Lake.

Date.	Drainage.	Salt removed.
1902.	*Cubic feet.*	*Pounds.*
September	158,700	152,200
October	265,000	196,100
November	251,000	353,800
December	139,700	187,600
1903.		
January	257,300	391,200
February	174,400	214,800
March	428,000	590,700
April	26,900	26,500
May	521,500	567,100
June	274,500	345,200
July	480,490	556,459
August	814,890	1,221,742
Total	3,792,380	4,802,601

From the foregoing tables it will be seen that there has been added to the Swan tract 8,305,411 cubic feet of water, equivalent to 57 inches in depth over the entire tract, and of this quantity 3,792,380 cubic feet, or 45 per cent, was recovered in the drainage. This drainage water, equivalent to 26.2 inches in depth over the entire tract, carried 2,401 tons of salt. Should we consider the seepage water which has drained

into the subsoil and not out through the drainage tile, it is likely that at least 4,000 tons of salt have been eliminated from the land.

Seventy-five per cent of the area of the tract at Salt Lake contained less than 0.40 per cent of alkali in the first foot of soil as against 2½ per cent one year ago, and the entire area, it is believed, will be sufficiently sweetened by the end of the present season to permit the growing of a shallow-rooted crop. It will be seen from this that the ultimate complete reclamation of the land seems assured, and the Department believes that the object lesson thus afforded the farmers of this and other arid regions will stimulate them to take up the work of reclaiming these waste but fertile lands.

The value of the alkali lands at Salt Lake City is only $8 an acre, while lands not affected by alkali bring from $100 to $350 an acre. The cost of installing the drainage system was about $16 an acre, so that even with the additional cost of the irrigation water the margin of profit in the reclamation of these lands is wide enough to interest capital.

Besides the work at Salt Lake City, a tract of 20 acres near Fresno, Cal.—where lands have depreciated not less than $1,000,000 in value in the last few years on account of the rise of alkali—was taken under lease for reclamation. This land was at one time sold for $350 an acre, but had become badly alkaline, and was abandoned and of merely nominal value at the time of undertaking its reclamation. The work at Fresno has been quite as successful as at Salt Lake City, and at the end of four and a half months the greater part of the 20 acres was in condition to permit the planting of alfalfa, which crop will be seeded as soon as the proper season arrives.

The cost of installing the drains at Fresno was $15 an acre, but at Yakima, Wash., where a third experiment is under way, the cost was $21 an acre, a difference due mainly to the higher price for drain tile. The system at Yakima has also been successfully installed, and land, worthless for agricultural purposes at the inception of the experiment, will, it is believed, be in as productive a condition at the end of two years as contiguous lands now valued at $150 an acre.

It is the purpose of the Department to establish six of these demonstration experiments in parts of the West where there has been great loss from the rise of alkali. The need for such object lessons has been forcibly impressed upon the Department by the apathy of the communities where the alkali evil exists and increases. The people seem to stand in awe of alkali and to doubt that they can cope with it, notwithstanding the insistent teachings of experts to the contrary. This is not the case in Egypt, where vast areas of land more salty than any but the very worst soils in the Colorado Desert have been reclaimed by practically the same methods as those recommended by the Department and now successfully in use in these experiments. And these demonstrations have been undertaken in the belief that when the people see that the rise of alkali can be prevented, or that where alkali has accumulated it can be economically removed, they will take the matter into their own hands and either privately or cooperatively set about the systematic protection and reclamation of these very valuable western lands.

TOBACCO INVESTIGATIONS.

Some supervisory work was done in Connecticut during the past fiscal year, but the large purpose of the Department, which was to

show the Connecticut tobacco growers that a wrapper leaf of superior quality could be produced on a specific soil type established in the soil survey of the Connecticut Valley, has been successfully brought to a close. It remains now for the growers to put the shade-grown Sumatra industry on a substantial basis, toward which condition great progress has already been made.

The investigation of the fermentation of Ohio tobacco has also been continued, and the interest in bulk fermentation, which is far better than the case method up to this time largely employed by the packers, is gaining ground.

The quantity of tobacco handled according to the method prescribed by the Bureau of Soils has increased from 655,200 pounds of the 1901 crop to 4,204,800 pounds of the crop of 1902. This tobacco is Zimmer Spanish and Little Dutch, varieties used in the manufacture of cigars, and the substitution of the bulk method of fermentation for the present practice of case fermentation will not only prevent great loss from rot and imperfect curing, but will also result in a general improvement in the several grades of this tobacco, and thus greatly increase the profits of the grower and packer.

By far the most important work of the Bureau of Soils during the past year, under the authorization for tobacco investigations, has been the experimental growing of Cuban cigar-leaf tobacco on certain soils in South Carolina, Alabama, and Texas. These soils, the Orangeburg sandy loam and the Orangeburg loam, are apparently very similar to the tobacco soils of Cuba, and the aroma of the leaf grown on one of these soils in Texas has been pronounced by the trade to be very fine. The crops grown on the experimental plots are now in course of fermentation, and it is too early to state definitely what the outcome will be, but so far as is now known the quality of the leaf will be excellent.

As these experiments in the South look toward the establishment of a new tobacco industry in that part of the country and to the production of a leaf to compete with the Cuban grown tobacco, a comparative statement of the production and value of the domestic leaf and the imports and value of the Cuban tobacco is appended.

Production and value of filler tobacco in 1901.

Type.	Production.	Value.
	Pounds.	
Ohio	35,654,314	$3,832,839
Pennsylvania	17,614,380	2,113,725
Other domestic filler	17,666,531	1,971,584
Total domestic filler	70,935,225	7,918,148
Imported Cuban, 1901	18,554,775	16,212,773

In the above table the production of the domestic tobacco is on the basis of the fermented leaf, 20 per cent having been deducted from the total production for shrinkage in fermentation and loss in handling. In the case of Ohio the necessary allowance for other types than the filler types grown in the State has been made. Two cents per pound has been added to the value of the domestic tobacco to provide for the expense of fermentation, etc., thus putting the Cuban imports and domestic filler on the same basis. It will be seen from these figures

that the Cuban imports, while only one-fourth as great in quantity, represent two and one-third times the value of the domestic product.

It is the purpose of the Department, if the results of this year's work warrant, to carry on the filler experiments in the South on broader lines, similar to those of the Sumatra experiments in Connecticut, and then to extend its operations into other States where the results of the soil survey show that tobacco can be raised or where improvements can be made.

WORK OF THE SOIL LABORATORIES.

Besides routine work the laboratories of the Bureau of Soils have been developing several special investigations in the physics and chemistry of soils. Much of their work is of a purely technical character, necessary to a proper understanding and handling of the large soil problems which the Bureau is investigating, but not in itself of immediate interest or value to the practical agriculturist. Some of the work, however, has an immediate interest and is of a far-reaching and fundamental character.

The subject of most practical importance to the farmers of the country is the yield of crops, which has been popularly believed to be more or less directly influenced and controlled by the chemical characteristics of the soil. The Bureau has therefore made an exhaustive research, the results of which modify very materially the current conceptions of this matter. In considering the question the aim was to determine what amount and proportion of the several mineral plant foods were actually in solution in the soil at any one time, or from time to time; since it has been admitted by practically all authorities that it is the solution naturally existing in soils which is the immediate source of the mineral foods obtained by the crops growing upon them. Birner and Lucanus, as long ago as 1866, pointed out that plants can be grown to perfection in well water if suitable physical conditions are preserved, and, as a matter of fact, they grew oat plants in such water, renewed weekly, the yield of grain being double that from a rich garden soil.

Until the work was undertaken in this Department it had never been possible to make a satisfactory study of this subject, owing to the difficulties encountered in isolating the natural nutrient solution from the solid soil and in analyzing this solution for the extremely small amounts of dissolved material maintained in it.

By careful work and unusual ingenuity these analytical difficulties have been surmounted by the Bureau and methods devised that enable us to obtain the soil solution and to estimate, with a degree of accuracy little short of marvelous, the amounts of the constituents contained which are of significance for plant growth. Moreover, by means of portable outfits it has been possible to make these determinations in the field, where local conditions can be studied in conjunction with the analysis of fresh soil samples.

The chief of the Bureau, Professor Whitney, concludes, from the consideration of some hundreds of examinations with these new and exceedingly delicate methods, that there is no apparent relation between the dissolved salts of the soils, as determined by the methods, and the yield of crops, and that there are no constant differences between the different types of soil, although these types differ widely

in their agricultural values. With such small differences as were actually found, quite as often the larger amount of plant food was found associated with a poorer crop, and vice versa; and, furthermore, the chemical differences between soils of various types with known wide variations in agricultural value, or between soils of the same type supporting on the one hand good, on the other poor crops, were no larger than those found between soils yielding approximately equal crops.

He argues, therefore, that nearly all soils are amply supplied with the necessary mineral plant food, and that these plant foods are not in themselves a matter of paramount importance to the agriculturist, for their supply as regards the plant is determined by the supply of soil moisture which the crop can obtain from the soil; that the chemical analysis of a soil can not in itself, therefore, throw much light upon the problem of fertility, but when the farmer attempts to control the factors governing crop yield his attention must be directed to the mechanical condition of the soil as affecting the supply of soil moisture with its dissolved mineral nutrient, to the effects of climate, to rotation, and to general soil management. These matters have all been fully treated in a recent publication (Bulletin No. 22) of the Bureau of Soils.

BUREAU OF STATISTICS.

WORK OF THE YEAR.

The work of the Bureau of Statistics has been continued on the usual lines. In addition to the regular work in estimating crop conditions, etc., statistical matter relating to the principal crops and farm animals, freight rates, exports, etc., in the United States and foreign countries has been prepared for publication, and numerous inquiries from various interested parties as well as Bureaus and Divisions of this Department have been answered, all of which has necessitated a vast amount of research and compilation.

Several special reports have been published during the year. These reports include a statistical description of the "Wheat Ports of the Pacific Coast," "Practices in Crop Rotation," "Flaxseed Production," "Commerce and Manufacture in the United States," "Milk Transportation: Freight Rates to the Largest Fifteen Cities in the United States," and "Relations of Population and Food Products in the United States."

FOREIGN AGRICULTURAL STATISTICS.

The statistical expert who has for some years had charge of the crop statistics of foreign countries competing with the United States has been stationed during the year in London, England, where he has been in closer touch with the statistical offices of the different European governments, whose reports, along with the most authoritative commercial intelligence of interest to American agriculturists, he transmits to Washington by mail or cable from time to time. Negotiations with the governments of various important grain-producing countries of Europe, and also with that of the Dominion of Canada, looking to a telegraphic interchange of crop reports similar to that already in operation between the United States and Hungary have been continued, and it is not improper to state that these negotiations have now

reached such a stage that there are good grounds for believing that the growing season of another year will see the American farmer placed in as prompt possession of trustworthy statistics concerning the principal grain crops of foreign countries as he is of those of the United States.

COOPERATION WITH OTHER BUREAUS AND DIVISIONS.

During the year there has been cordial cooperation between the Bureau of Statistics and the Bureau of Plant Industry, the Bureau of Animal Industry, the Bureau of Forestry, and the Bureau of Soils, with such satisfactory results as to assure even greater cooperation and mutual dependence in the future than in the past. Throughout the whole of the research work of the Department the best results have been obtained by the cooperation of one set of specialists with another. The statistical work contained in the various publications of the different branches of the Department of Agriculture is largely done by employees of the Bureau of Statistics, and such statistical work as is not done in that Bureau is carefully revised by the Statistician and receives his approval before being published as the work of any other Division or Bureau of the Department.

COST OF CROP PRODUCTION.

In cooperation with the State Agricultural College of Minnesota, an investigation is being conducted by the Division of Statistics to determine the cost of production per acre of the principal crops. Although this work is not sufficiently complete to permit of publication of results at the present time, these data, when properly tabulated and analyzed, will undoubtedly be of great value in solving questions of farm management, and various other problems that confront the modern farmer.

THE STATISTICAL LIBRARY.

While there is no branch of statistics having a close relation to the agricultural industry that is not more or less adequately represented in the Department's statistical library, as regards the literature of prices, it is believed to be the best equipped library in the country, and no reasonable expenditure that may be necessary to maintain its present high standing should be withheld. Its card index to agricultural statistics is exceptionally complete and well arranged and has proved of great value to visitors who have had occasion to consult it.

BUREAU ORGANIZATION.

On July 1, 1903, the Division of Statistics became a bureau, and the Division of Foreign Markets was placed under the direction of the Statistician. Both the clerical and field forces will now be materially strengthened, and, while the work must necessarily be continued along practically the same lines as heretofore, no effort will be spared to strengthen and improve the reports on the staple crops and give more detailed information with regard to fruits and various minor crops. Until the present year it was found impossible to make quantitative estimates of any but the principal crops, but flax was added during the year, and the necessity for extending this work to

embrace other products—such as rice, sugar, fruits, etc.—is every day being more forcibly brought to the attention of the Department. With a moderate addition to the field force the organization for collecting data will be sufficiently well organized to enable the Statistician to include details of all minor crops and of fruits in his monthly reports. But to successfully extend the work to embrace these crops it will be necessary to strengthen the office force by the appointment of a sufficient number of computers to collate and analyze the reports sent in by correspondents and field agents.

The organization of the field force has already been carried to a very high state of efficiency, and it is proposed materially to increase this efficiency by the appointment of additional field agents so soon as the bureau organization becomes effective.

It is my desire to so strengthen this Bureau as to enable it to become, as I conceive it should be, the principal source of reliable information on the agricultural resources of the country.

FOREIGN MARKETS.

COMPREHENSIVE INVESTIGATIONS.

Special comprehensive investigations involving much labor in the collection of statistics and in table building have engaged the efforts of the Division of Foreign Markets during the fiscal year. These investigations bring together vast amounts of information concerning the trade of this and other countries in exporting and importing farm and forest products which has not hitherto been in form readily available to the general public.

TARIFFS OF FOREIGN COUNTRIES.

On account of the numerous changes in the tariff laws of many important countries, frequent inquiries are referred to this Division for information regarding tariff rates and customs regulations of certain agricultural products in foreign countries.

In order to supply this information in condensed form, the Bureau has been charged with the publication of a series of bulletins giving, in English, the import duties on certain important groups of agricultural products that are levied in foreign countries.

The greatest care has been exercised to make this information accurate, and no efforts have been spared to get the most recent information from each country.

The countries, including their colonies and dependencies, for which these tariff schedules have been compiled, number 162, which includes, for the sake of completeness, the tariff of the United States and that of the Philippine Islands.

FIFTY YEARS OF EXPORTS.

The numerous demands for information as to export statistics of farm products from the United States, covering a period of years longer than the ten-year statements customarily made by this Division, have suggested the compilation of tables showing these exports for a long period of years, beginning with 1851. From these tables are

derived the figures on our exports of farm products given in the earlier portion of the present report.

These figures exhibit a steady and regular increase in the volume of our agricultural export trade, in which cotton, grain and grain products, and meat and meat products were the principal factors. Other important items were live animals and tobacco. The five items mentioned have formed the bulk of our agricultural export shipments throughout the period 1851–1902, with the exception of the years 1861–1865 when, on account of the civil war, our exports of cotton were almost entirely suspended.

GERMAN IMPORTS OF FARM PRODUCTS.

The imports of farm products into the German Empire were made a special subject of inquiry by the Division of Foreign Markets, and resulted in a full analysis of products by kind and by country of origin.

Farm products constitute a much larger percentage of the imports of the German Empire than they do in this country, the percentage for Germany being 59.2 for the five years 1897–1901. The average annual value of the farm products imported from 1897 to 1901 was $745,198,480; the amount for 1901 was $790,564,700, of which amount the United States supplied 21.9 per cent. Of the imports of agricultural raw materials, the United States supplied 20.5 per cent; food products, 21.7 per cent; feed stuffs, 37.3 per cent; miscellaneous farm products, 3 per cent.

As contributors to the imports of farm products into Germany the various countries rank in order as follows, with the percentage of imports derived from each: United States, 21.9 per cent; Russia, excluding Finland, 16.3 per cent; Austria-Hungary, 10.6 per cent; British East Indies, 5.6 per cent; Argentina, 5.4 per cent; Italy, 4.4 per cent; France, 4.4 per cent; the Netherlands, 4 per cent; Brazil, 3.2 per cent; Belgium, 2.8 per cent; United Kingdom, 2.7 per cent; Dutch East Indies, 2.4 per cent; British Australasia, 2.4 per cent; Denmark, 1.6 per cent; Switzerland, 1.6 per cent; Roumania, 1.3 per cent. No other foreign country has a percentage as high as 1.

TRADE IN FOREST PRODUCTS.

This subject, which had hitherto received scant attention, has been made a prominent subject of investigation during the year just closed, and will hereafter receive the attention of this Division in conjunction with the subject of trade in farm products.

While it is true that in the immense aggregate of our foreign trade forest products occupy a small place relatively, yet, expressed in value, this trade has grown to large proportions, the growth being more especially manifest in exports than in imports. The domestic exports of forest products in 1893 amounted to $28,127,281, and during the five years 1893–1897 the annual average was $31,782,928. During the following five years, 1898–1902, the annual average grew to $47,648,530, the highest amount for one year being $55,369,161 for 1901. This average was considerably exceeded in 1903, when the amount was $58,281,124. During the eleven years the value of the domestic exports of forest products was about 3 to 4 per cent of the total domestic exports.

During the five years 1893–1897 the annual average value of the imports of forest products was $44,638,795, an amount from which the imports for each year did not vary much. In the following five years the annual average increased about $10,000,000, making the average for 1898–1902 $55,205,996; the highest amount for one year was $60,633,078, in 1900. In 1903 the value of the imports of forest products rose to the highest figure yet attained, $71,478,022. The relation between the value of the imports of forest products and the total imports is expressed by 5.9 per cent for the five years 1893–97, being 7.1 per cent for the five years 1898–1902 and 7 per cent for the year 1903.

The imports of forest products are constituted chiefly of various gums, india rubber, cork, dyewoods and their extracts, and cabinet woods; also timber, lumber, and wood pulp, principally from Canada. It appears, then, that the principal portion of these imports is of materials that do not grow in this country or, if growing here, are not produced in sufficient quantities for the demands of consumption, as in the case of timber, lumber, and wood pulp.

The imports of agricultural products for 1903 amounted to $456,199,325, a higher amount than for any preceding year and $36,060,037 greater than for 1900. Of the total imports, 44.5 per cent are classified as belonging to farm products. This percentage shows a decline; for the five years 1893–1897 it was 51.5 per cent and for the five years 1898–1902 it was 48.7 per cent.

Farm products have declined as an element of domestic exports also during the last eleven years, although no decline is perceptible during the last five years. In 1903, 63.1 per cent of the total domestic exports was composed of farm products.

Upon combining the domestic exports of forest products with those of farm products, the total constitutes 67.3 per cent of all domestic exports for 1903. The percentage for the preceding five years was 68.8. The value of the farm and forest products exported for 1903 was $936,760,575, compared with which is the annual average of the preceding five years, $908,686,344, and the average of the five years 1893–1897, $647,857,875.

These two classes of products constituted 51.4 per cent of the imports of 1903, the percentage for the preceding five years being 55.8 and for the five years 1893–1897, 57.1. In value the imports of these two classes of products in 1903 amounted to $527,677,347, in comparison with which are the annual average of the five preceding years, $434,331,088 and the annual average of the five years 1893–1897, $33,805,721.

DIVISION OF ENTOMOLOGY.

WORK ON INSECTS FROM ABROAD.

THE ASIATIC LADYBIRD ENEMY OF THE SAN JOSE SCALE.

In the report of last year a rather full statement was made concerning the importation of a ladybird enemy of the San Jose scale, found in China and Japan by the first assistant entomologist. During the late summer of 1902 eight colonies of this beetle were distributed in six States. In the experimental orchard of the Division of Entomology the insect wintered well out of doors, and

started breeding early the present season. The colonies distributed during that summer were mainly put in charge of entomologists of State experiment stations. During the early summer of 1903 some 26 colonies were distributed in Maryland, North Carolina, Georgia, Alabama, Delaware, New Jersey, New York, Ohio, Oregon, Tennessee, Virginia, and West Virginia.

Of last year's distributions, those sent to Georgia have given the best promise. One of these established in a large orchard of 17,000 peach trees, with a contiguous orchard containing 250,000 trees, both orchards infested with scale, shows the most satisfactory results. By the 1st of July, 1903, the ladybird had spread through the original orchard of 17,000 trees and then occurred to the number of thirty or forty thousand. Three additional broods are expected during the season, and these numbers should be vastly augmented. Colonies have been distributed from this orchard to various parts of Georgia.

The experiences of the year have, therefore, been very encouraging. Every effort will be made to distribute this beetle throughout the regions where the San Jose scale occurs. The work, however, is still in the experimental stage, and too great hopes should not be aroused. Recommendations for the prompt application of sprays and other remedial treatment should not be neglected.

OTHER BENEFICIAL INSECTS.

The fig fertilizing insect continues to be a great success in California. Large crops of figs were raised at Fresno, and the quality seems to have been even better than during the previous year. A number of new orchards of Smyrna and capri-figs have been started, and there is no doubt that the insect has been thoroughly acclimatized at Fresno and at Niles.

One of the most striking of the recent beneficial results of these introductions has been the good work done by the parasitic enemy of the black scale (*Scutellista cyanea*) which was originally imported by the Division of Entomology from Italy and later from South Africa, and established in the orange and olive groves of California. The best work has been done in the southern part of the State, where the insect has been established in every county south of Point Conception. It is very plentiful in Los Angeles, Orange, and San Diego counties, and is still being sent out from the office of the First Deputy Commissioner of Horticulture at San Francisco. The Los Angeles commissioners distributed over 400 strong colonies at Escondido. At Pasadena the insects have spread naturally, and in the colonization districts over 90 per cent of the black scale has been destroyed by the parasite, which is still breeding.

WORK ON THE COTTON BOLL-WEEVIL.

The continued spread of the cotton boll-weevil, and the danger threatening the most important industry of the South by the direct prospect that it will soon reach all portions of the cotton belt, resulted in the appropriation by Congress of $20,000 for a continuation and enlargement of the work of the Division with that pest. This work was under the direct charge in Texas of Mr. W. D. Hunter, who was aided by a number of assistants.

The funds at the disposal of the Division enabled it for the first time to conduct experiments with the cultural methods of controlling the pest on a large scale. This was accomplished by entering into contract with two representative large planters in typical situations in Texas. By the terms of these contracts the planters agreed to plant, cultivate, care for, and in every way manage the crop exactly in accordance with the directions of the agent in charge. In this manner the Division was given practically complete charge of 325 acres, but without the trouble and expense of renting the land and working the crop. These experiments were located at Calvert, in the Brazos Valley, the most seriously infested portion of the territory at present, and at Victoria, in the extreme southern portion of the State, where the existence of volunteer cotton furnishes the weevils with food very early in the season, thus adding an important feature to the problem that does not occur elsewhere.

At Victoria a field laboratory was fitted up, where a thorough study was made of every feature of the life history of the weevil. The matter of parasites and the possibility of controlling the pest by their artificial propagation, which has always appealed strongly to many planters, received especial attention. In pursuance of this feature of the investigation the agent in charge made a trip to Mexico, where the governmental commission that had been created for the study of the weevil problem has especially concerned itself with the propagation of a mite (*Pediculoides ventricosus*), which, at least under certain conditions, has been found to destroy the larvæ of the pest. The agent made a study of the methods pursued in the laboratory of the commission at Cuernavaca, and through the courtesy of Prof. A. L. Herrera, the head of the commission, he was enabled to bring back to Texas a large number of cultures. These parasites were distributed from the laboratory at Victoria. The work is being continued this season, but the indications are that climatic conditions will always render unobtainable in Texas whatever useful results may have been obtained in Mexico.

WORK ON INSECTS DAMAGING FORESTS.

With the beginning of the fiscal year a section of the Division of Entomology was organized for the investigation of insects injurious to forests. Dr. A. D. Hopkins was put in charge of this work, and during the year three assistants were assigned to him. The work was carried on in cooperation with the Bureau of Forestry, and investigations have been made in nearly all of the States and Territories. Depredations by a bark beetle on the Silver Pine, Red Fir, and Lodgepole Pine in the Priest River Forest Reserve in Idaho, and by an important wood-boring enemy of the Red Fir near the Olympic Forest Reserve in Washington, were investigated.

An important result of the work of the year was the determination that the destruction of many large areas of timber, which was supposed to be the result of forest fires, was primarily the work of insects, the insects having killed the timber, which then offered favorable conditions for the starting of extensive fires. A serious trouble affecting the pines in the Rocky Mountain region from Arizona to Idaho, caused by bark beetles and which resulted in the death of a vast amount of timber in the national reserves and on public and private lands, was also investigated.

Many other similar investigations were carried on, and the most encouraging progress was made in the attainment of the principal object of the work, namely, the discovery and practical application of methods of preventing losses from the ravages of forest insects. The recommendations for checking the rapid spread of pine-destroying beetles in the Black Hills were adopted by the General Land Office of the Department of the Interior with good results, as were also recommendations for the control of the serious insect trouble affecting the pine timber on some 200,000 acres of forest and ranch land in northeastern New Mexico.

Three field stations were established, one in the Black Hills, one at Tryon, N. C., and one at Hoquiam, Wash.

WORK ON THE CODLING MOTH IN THE NORTHWEST.

This work, which has been referred to in previous reports, was completed during the autumn of 1902. The special agent in charge during the following winter completed a full report on the investigation, which indicates very satisfactory results. Demonstration on a large scale of the efficacy of the measures adopted and recommended showed to the satisfaction of all concerned that the economical control of the codling moth in the Northwest is possible. It was conclusively shown that in the infested regions of the far Northwest from 85 to 100 per cent of the fruit was injured if no remedial measure was used, but that on intelligent application of the remedies advised by the Division of Entomology from 85 to 98 per cent of the fruit might be saved.

OTHER INVESTIGATIONS.

The work upon injurious scale insects has been carried on through the year. The methods of controlling the San Jose scale have become more effective, and the advice issued by the Division of Entomology is embodied in two recently published and revised circulars giving the latest methods of control. Much work was done in the determination of scale insects for experiment stations and individuals, including the study of considerable material received from foreign sources, and especially from our new possessions, Porto Rico and Hawaii.

The investigations of insects injurious to truck crops have been carried on, and a special study has been made of those forms which injure the sugar beet.

The work on insects injurious to stored products has also been measurably successful, and the remedies proposed for this class of insects have been successfully tried by many individuals. An especial study has been made of the injuries of the so-called powder-post beetles to the wood used in making agricultural tools and furniture.

The insects affecting ornamental plants have also been studied to advantage.

The investigations of insects in their direct relations to the health of man, which have been under way for two years past, have been continued. Careful studies have been made of the habits and geographical distribution of the mosquitoes which convey malaria and those which convey yellow fever. An extensive investigation of the insects attacking the stems of growing wheat, rye, barley, and oats, not, however, including the Hessian fly which was earlier dealt with,

has been completed during the year, and a final report prepared for publication.

The insects which affect mushrooms, the gadflies or horseflies, the insects which affect the seed of the clover plant, and the insects which affect the cranberry have been studied during the year and are being written up.

The work on insects affecting shade trees, which has been carried on now for several years, has been continued, and the preparation of an extensive bulletin on this subject is under way.

WORK IN SILK CULTURE.

An appropriation of $10,000 to the Department of Agriculture for investigations in silk culture was made by Congress for the fiscal year 1903. The conduct of this investigation was placed in the hands of the Entomologist. Previous work by the Department in the years 1882 to 1891 had already demonstrated the possibility of raising excellent cocoons of the domestic silkworm in all parts of the United States in which the White Mulberry tree will grow. Therefore, in the investigations to be undertaken at this time, the whole attention of those in charge is naturally devoted to the main practical aspects of establishing the industry. Undoubtedly the first steps are to create a general interest in the subject, to insure the supply of leaves for food for the worms, and to educate as many persons as possible in the care of the worms, so that a crop of cocoons will be assured to any individual or company desiring to go into the reeling business. The Entomologist, during the summer of 1902, visited the silk-growing regions of Europe and investigated the establishments for the selection of pure eggs and also investigated the communities in which silk culture has its strongest hold. He also contracted for the purchase of two four-basin reels. Considerable quantities of silkworm eggs of the best races were purchased, and mulberry seeds and cuttings of the best varieties were also contracted for.

During the winter and early spring eggs were sent in small quantities to all applicants who were able to assure the Department that they had at hand a proper supply of food for the worms. To those who had no food mulberry cuttings were sent. A small crop of cocoons was raised at the Department in the spring of 1903. Nearly all of the persons to whom eggs were sent reported that they had been able to rear the worms and produce the cocoons without great difficulty, and letters were sent informing the raisers that their cocoons would be purchased by the Department at the current European market rates. One of the reels imported from Europe was put in operation at the Department of Agriculture, in Washington. Two expert reelers were secured from France, and at the close of the fiscal year reeling operations were about to begin. The second of the four-basin reels was loaned to The Seri-Culture and Manufacturing Company, at Tallulah Falls, Ga., where extensive planting of mulberry trees has been carried out and where experimental work is promised.

The establishment of the silk industry in the United States must be a matter of extremely slow accomplishment. Small appropriations by the General Government will assist in the education of an increasing class of silk raisers. The lack of a market for cocoons is the great difficulty at the present time. The limited market created by the

Department out of this small appropriation is in reality an artificial one. It is necessary, however, to induce people to continue their interest in the subject and to educate a class of silk raisers, and for the present this method will be continued.

APICULTURAL INVESTIGATIONS.

The correspondence in relation to apicultural matters has been constantly increasing, and has covered a wider range of subjects.

In the autumn of 1902 a trip was made by the apicultural investigator through Nebraska and Colorado for the purpose of investigating certain conditions, especially in Colorado, regarding natural and artificial bee pasturage and the early breeding up of colonies of bees to enable bee keepers to take full advantage of the first crop of alfalfa. The recommendations made to cultivate early pollen-bearing crops, such as Russian hairy vetch, and to employ more prolific, hardy, and strong-winged bees than Italians, such as the Carniolan and Cyprian races and their crosses, have, wherever followed, resulted in a marked increase in the honey yield and in earliness and size of swarms.

A number of queens of select breeding have been sent this year, as in the past, to experiment stations engaged in apiarian investigations, and for testing in sections where it seemed advisable to try certain breeds or crosses.

A race of bees little known in this country, the Caucasian, native to the southeastern provinces of Russia, bordering on the Black and Caspian seas, has been under observation. It promises to be a valuable addition to the varieties already bred in this country. The workers are good honey gatherers and most remarkably gentle. The queens are quite prolific. The exact status of the race as regards hardiness has not yet been determined, although in Colorado they have not seemed inferior in wintering qualities to the Italians already there.

EXPERIMENTAL WORK WITH INSECTICIDES.

The value of the standard insecticides, both for biting and sucking insects, including food poisons and substances which kill by contact merely, has been established by many years of experiment, but nevertheless, by the practical work of the Division of Entomology, such standard insecticides receive each year the indorsement of additional satisfactory experience. This applies not only to the control of insect enemies of field and garden crops and fruits, but also to house pests, as illustrated by additional practical work done during the year with the hydrocyanic acid gas treatment of houses described in the last annual report. The experimentation with petroleum oils, referred to in the former report, has been started during the present year in conjunction with the Bureaus of Plant Industry and Chemistry of this Department. This work, it will be recalled, was undertaken in response to special requests from the Society for the Promotion of Agricultural Science and from the Association of Economic Entomologists.

BIOLOGICAL SURVEY.

The Biological Survey is engaged in three distinct lines of investigation, each of which is as important and independent as the usual work assigned to a division of the Department. These lines consist of (1) the mapping of the boundaries of natural life and crop zones of the

country, from which may be determined the agricultural products suitable to the different climatic conditions that prevail in different parts of the country, and so likely to be a commercial success; (2) investigation of the economic relations of birds to agriculture and horticulture, in order to determine what birds are useful and what injurious to these interests and to what extent; and (3) the preservation and introduction of game, and also the supervision of the importation of foreign birds, to prevent the introduction of undesirable species, such as have caused much damage in other countries or are likely to become pests in this country.

DETERMINATION OF LIFE AND CROP ZONES.

In determining the feasibility of profitably raising a certain kind of crop for market the first question presenting itself is, Is the climate suitable? This question is largely determined by biological surveys or the investigation of the geographic distribution of plant and animal life. Lines are run through a State wherever necessary, and the plant and animal life and effects of physiographic and climatic conditions are carefully noted. From these lines maps can be made, showing the location throughout the State of life zones—in other words, belts that are adapted climatically to certain crops.

During the year the survey of Texas has advanced to such a point that a little additional work will permit the mapping of the life and crop zones and the publication of a full report of the biological character of the State. This survey should obviate many expensive agricultural experiments.

California presents peculiar difficulties to this work owing to the great diversity of climate found throughout the State, ranging from the Alpine summits of mountains, with their perpetual snow, to torrid deserts, hotter and drier than those of Africa, and including regions where frequent fogs and heavy rains prevail. The enormous agricultural interests of California, with its shipments of more than $60,000,000 worth of vegetable products annually, add materially to the value of the final result. As soon as available funds and the difficult character of the country will permit, a biological map of the State will be published, which, it is believed, will be of inestimable service to agriculturists and horticulturists of the State.

It is very desirable to secure as much information as possible concerning Alaska, in view of the tide of immigration setting in toward that Territory and its consequent development. Work was carried on at several points in the Territory, choice being made of such as would yield the broadest possible results with the limited means available for the purpose. The base of the Alaska Peninsula, on both coasts, and several of the lakes and rivers of the interior, notably Lakes Iliamna, Clark, and Becharof, and the Chulitna, Nushagak, and Ugaguk rivers, were the field of exploration. This region is one of unusual importance for biological investigations, as it includes the northwestern limit of the Pacific coniferous forest and is the point of junction of several life areas.

ECONOMIC RELATIONS OF BIRDS TO AGRICULTURE.

The study of the relations of birds to agricultural interests was continued under the two lines that have heretofore occupied attention, namely, laboratory work and field investigation. In the laboratory

attention was mainly directed during the past year to the stomachs of game birds, in preparation for issuing a report upon their food habits, in order to meet a constantly growing demand upon the subject.

Field work included a continuation of investigations on a certain Maryland farm, which formed the subject of one of the bulletins of the Division issued during the year, and the study of the food habits of birds in the principal fruit-growing districts of California, begun in 1901. The California work, as noted in previous reports, has yielded important results, which will be very useful to horticulturists by making it apparent which birds are serviceable and which are injurious to their interests.

Complaints have been received by bee keepers in California of great harm to their business, caused by certain birds, which, it is alleged, destroy large numbers of worker bees. Partial investigations of this complaint do not sustain these charges, but further study is necessary before a final report can be made.

In many parts of the country serious loss is entailed on agriculturists by periodic invasions of noxious insects. When such outbreaks occur hereafter they will be investigated, if practicable, by this Division in conjunction with the Division of Entomology, in order to ascertain, as far as possible, what influence is exerted by birds in checking the increase of the pests and thus diminishing the extent of their ravages.

GAME PROTECTION AND INTRODUCTION.

ENTRY OF FOREIGN BIRDS AND ANIMALS.

The duties assigned to this Division relating to game protection are based on three acts of Congress—the Lacey Act of 1900, the egg act of 1903, and the Alaska game law of 1902. The permits required by the Lacey Act for the entry of foreign birds and animals numbered 387 during the year, and allowed the entry of 629 mammals and 53,106 birds. Under the egg act 2,000 eggs of game birds were imported. Importations of cage birds are made mainly at New York and San Francisco, though parrots are frequently entered at New Orleans and different ports of entry along the Mexican border. Pheasants of various kinds for propagation are imported from Canada in considerable number, coming chiefly through the ports of Detroit, Buffalo, and Niagara Falls. The animals that are brought into the country are almost entirely confined to such as are designed for exhibition purposes in circuses and zoological parks. Most of the importations of cage birds are made by regular dealers, and are subject to the usual inspection. In the case of passengers bringing in a few birds as pets, it has been found desirable to obviate the annoyance sometimes caused by the delay needed to secure permits, and the facilities granted at New York have been extended to San Francisco. Under the arrangement thus made not more than five birds may be declared by passengers with their personal baggage before an officer of the customs and landed without formal permit. A strict account of the birds thus entered is kept by the customs authorities and reported quarterly.

The object of the law is to eliminate the danger of the introduction of birds or animals which might become serious pests. That such

danger is constantly present is shown in the history of Australia, Porto Rico, Hawaii, and other countries, and is instanced by the introduction and spread in the United States of the European sparrow, and to a much more limited degree of the Old World starling. Although the entries at San Francisco are few as compared with those at New York, the danger of introducing injurious species at that port is probably greater than at any other. With a view to still further improving the service at San Francisco, a careful examination was made there in June of the peculiar conditions attending importations from Australia and the Orient, which, it is believed, will be productive of much good. It is hoped that all danger of the introduction of such species as may prove to be pests can be eliminated. So far as is known, the law has thus far been effective. Two mongooses from Jamaica were killed at Philadelphia; 1 mongoose from the Philippines and 2 flying foxes from Australia were destroyed at San Francisco; and 50 flying foxes that arrived at New York from Singapore in December were reshipped to Hamburg, Germany.

ENFORCEMENT OF GAME LAWS.

The cordial cooperation of the Attorney-General and State officials has enabled prompter disposition of cases arising from the illegal shipment of birds and game than ever before. Thirty-five such cases, involving the shipment of 3,729 birds, were reported to the Department, a decrease of four cases and about 1,300 birds from those reported during the preceding year. Since the passage of the act 40 convictions have been secured in cases passing through this Department, and about 20 cases are still pending. Efforts have been concentrated upon one or two areas in the West, where illegal shipments seem to be especially frequent, in order to secure more satisfactory results with the limited means available. Illegal shipment of game has been very frequent in the past, and various methods have been adopted to conceal the character of the shipment. The violators of the law have, however, been driven by increasing insecurity in their illegal trade to new devices. Thus, a consignment recently seized in the Northwest disclosed game birds concealed in bales of hay which had been forwarded by slow freight. In the attempt to curtail these illegal shipments, I have been much aided by the cooperation, cheerfully and cordially given, of express and railroad companies, and there is reason to believe that illicit shipments can, at comparatively small cost, be reduced to a minimum and the great inroads they make upon the game of our country checked.

PROTECTION OF GAME IN ALASKA.

In Alaska, in the absence of a specific appropriation permitting the employment of competent wardens, it has been impossible to secure a reasonable observance of the game law. Much care has been exercised, however, in the case of the export of heads and skins, and the shipment of these from Alaska for purposes of sale in the United States in violation of the law has been practically stopped. Misinterpretation of the statute was the means of temporarily curtailing the trade in black bear skins, but the misconception has been corrected as far as possible.

PUBLICATIONS.

Under the provision of the Lacey Act requiring the collection and publication of useful information relating to the propagation, uses, and preservation of birds, posters and bulletins have been published annually, showing the close seasons and other provisions of the game laws of the United States and Canada, also lists of game officials in the various States, and other information of like character. The digest of game laws was issued as a Farmers' Bulletin in order to meet the demand and to place a sufficiently large number at the disposal of members of Congress. The compilation of laws relating to nongame birds has been of considerable service. Much of the rapid progress in the character of the legislation protecting birds is directly traceable to the dissemination of the information it contains, and it is noteworthy that the adoption of our system of bird protection has recently been strongly advocated in Brazil and Mexico.

RECOMMENDATIONS.

It has been found impracticable to transport, fence, and maintain elk and other animals on forest reserves and other public lands with the appropriation of $1,000 made for that purpose. I have recommended, therefore, an increase of the appropriation to $5,000 for the ensuing year.

The three distinct lines of work assigned to this Division could be conducted much more economically and effectively were the Division reorganized as a bureau of three divisions, each to have charge of one of these lines, and were a larger amount appropriated for the performance of the work. I have accordingly recommended such reorganization, with an increase of $1,450 in the statutory roll and $12,000 in the lump fund, in order to accomplish this change and meet the greatly increased demands of some of the sections of the Division.

OFFICE OF EXPERIMENT STATIONS.

PROGRESS OF THE EXPERIMENT STATIONS.

The success of the agricultural experiment stations in leading the way to the improvement of agricultural practice on a grand scale is having as one of its effects a closer union between the stations and the farmers in enterprises directly affecting farm methods. This is leading to demands that the stations shall conduct at least a portion of their investigations in a larger and broader way, in order that the results of scientific investigations, whether in the field or the laboratory, may be more definitely and thoroughly applied in practice under the conditions actually encountered on the farm. A good example of this may be found in the recent cooperative experiments conducted by the Iowa Station at Odebolt, Iowa. The proprietor of a large farm at that place desired to know whether or not the by-products of corn, flaxseed, or cotton seed, or some of the prepared stock feeds when fed in conjunction with corn, would give better results than corn alone. He furnished 220 cattle and the corn roughage necessary for conducting a feeding experiment. The Iowa Station

furnished the by-products and stock feeds and conducted the experiment. The first test gave results indicating that the addition of so-called condimental stock feeds to a corn and wheat-straw ration gave much lower returns per steer than corn and wheat straw alone.

One of the results of the thorough work of the Illinois station on the breeding of corn has been the formation of the Illinois Seed Corn Breeders' Association. The success of this enterprise has been phenomenal. All of the available supply of the improved seed is rapidly disposed of to farmers and much of it is engaged in advance. The work of this station on corn is proving to be far reaching in its results, not only in improving the general quality of seed corn, but in inducing practical men to undertake the breeding for special qualities—for protein, for oil or for starch—which the station has demonstrated to be entirely feasible. As a recognition of the value of such work, the farmers' organizations of Illinois have rallied to the support of that station, securing last year State appropriations aggregating $46,000 for special investigations and this year nearly twice that amount, or $85,000.

The Minnesota station has been extending its investigations in the breeding of improved varieties of wheat and other kinds of grain, making thousands of crosses, and, wherever promising new varieties are found, testing them in a large way, both at the station and on hundreds of farms throughout the State.

The amount of data published by the stations on many agricultural subjects is now very large, and the recent attempts which have been made to reduce this material to organized form in order that it may be utilized for purposes of agricultural education have shown that the stations are doing a great work in supplying the materials out of which a definite science of agriculture is being constructed, and on which courses of instruction in agriculture of different grades can be successfully based.

If our stations are to be continued on the broad basis on which they are at present organized they must generally be supplied with larger funds for the general expenses of investigations in order to conduct their work in a thorough and satisfactory manner. The States can and undoubtedly will supplement the National funds more fully as time goes on, but since the results obtained by the stations are in many cases of general value to the agriculture of the United States, it is worthy of consideration whether they should receive additional financial aid from the National Government. This supplemental aid should, if given, be granted under conditions which will insure its exclusive application to meet the expenses of agricultural investigations.

THE AGRICULTURAL COLLEGES.

Special appropriations for the better equipment and maintenance of the agricultural colleges, aggregating more than $1,250,000, have been made by the States during the past year. The movement in the direction of basing the courses of instruction in these institutions more largely on the science and practice of agriculture itself is continuing, and already has resulted in a considerable increase in the number of students pursuing agricultural courses. A special effort is now being made in a number of our strongest agricultural colleges to make their

courses more complete by adding systematic instruction in farm mechanics and rural economics. Increasing attention is being given by these colleges to the holding of summer schools, one purpose of which is to prepare teachers for giving instruction in nature study and elementary agriculture in the common schools. The interest in work of this kind is especially strong in the South at this time, as is shown by the large enrollment of teachers in the Southern institutions. The attendance at the land-grant colleges for the year 1902 aggregated 46,699 students, of whom 6,299 were in agricultural courses. The graduates of these institutions in 1902 were 4,443, and since their organization, 50,026.

This Department is cooperating with the Association of American Agricultural Colleges and Experiment Stations in the preparation of a comprehensive exhibit at the Louisiana Purchase Exposition showing the progress of agricultural education and research in this country.

SECONDARY AND ELEMENTARY SCHOOLS OF AGRICULTURE.

The attendance at the two county agricultural high schools opened in Wisconsin in the fall of 1902 was large, and the interest manifested in these schools was so great that the State legislature at its last session, recognizing the demand for instruction of this grade, made provision for additional county agricultural high schools with State aid. At the California Polytechnic Institute, San Luis Obispo, buildings have been erected and everything put in readiness for opening the school with agricultural courses this fall. The Mount Harmon School, near Northfield, Mass., founded by the late D. L. Moody, has decided to establish an agricultural department and to offer courses of instruction in that subject. The school already has an equipment consisting of a farm of about 1,000 acres, a dairy of about 200 cows, fruit orchards, and a cannery for putting up vegetables. Mr. Harry Hayward, a graduate of the school and for several months past assistant chief of the dairy division of this Department, has been called to the school as director of the agricultural department. This step on the part of one of the largest secondary schools of the United States is a matter of great interest to those who are following the progress of secondary instruction in agriculture, and is especially significant from the fact that the institution is not a technical school and this is the first attempt to establish an industrial course.

The committee on methods of teaching agriculture of the Association of American Agricultural Colleges and Experiment Stations made a report to the convention of this association held at Atlanta, Ga., in October, 1902, in which it showed that courses in agriculture could be introduced into the public high schools without any violent or radical reorganization of existing programmes for such schools.

Many of the officials in charge of our public high schools and elementary schools are also considering the advisability of introducing agricultural subjects into the curricula of these schools, more especially by giving an agricultural trend to nature-study work.

School gardens, meaning by the term flower and vegetable gardens utilized for educational purposes, are found in the East, the Middle West, the South, the far West, and our insular possessions. They are maintained in connection with the kindergarten and with every other grade up to the high school.

This Department has been aiding the school-garden movement in several ways. Through the Bureau of Plant Industry it has distributed special packages of vegetable and flower seeds to a large number of schools, and conducted a number of school-gardening experiments in cooperation with the schools and charitable organizations of Washington, D. C. Officers of the Department have in several instances volunteered to direct these experiments outside of office hours. One of the most successful of these experiments was conducted on the Department grounds with a class of 30 boys and girls from a near-by school, under the direction of the science teacher in the normal school of the city.

THE FARMERS' INSTITUTES.

In consequence of the action of Congress during the session of 1902–1903, making definite provision for the work of the Office of Experiment Stations relating to farmers' institutes, it has been possible to put this work on a permanent basis and to begin the formulation of a policy regarding its development.

As a result of a civil service examination, Prof. John Hamilton, of Pennsylvania, was appointed farmers' institute specialist. He has been for many years a lecturer and manager of farmers' institutes, and is thoroughly acquainted with their past development and their present needs.

Since the work of this Department relating to farmers' institutes is based on the principle of giving aid to the institutions maintained under the authority of the States, this Department has established the rule of working in this line through the State officers charged with the management of the institutes.

It is difficult to realize the extent and importance of the farmers' institute movement and its vital relation to the successful incorporation of the results of scientific investigations in our agricultural practice. Under present conditions, with the rapid changes in the personnel of our agricultural population and the almost entire absence of agricultural instruction in our elementary schools, it is of the greatest importance that our adult farmers shall receive definite information regarding improved methods of agriculture and the principles which lie at the foundation of progress in agricultural practice.

EXPERIMENT STATIONS IN ALASKA.

During the fiscal year ended June 30, 1903, experiment stations were maintained at Sitka, Kenai, and Rampart, and a new station established at Copper Center, the experimental work for the most part including the growing of cereals and vegetables, methods of reclaiming, draining, and fertilizing land, and the curing and ensiling of crops. The distribution of seed of hardy varieties of vegetables, cereals, and grasses has been continued and extended, and beneficial results have accrued, as is shown by the constantly increasing number of gardens and other plats of ground which are brought under cultivation. The supervision of voluntary observers of the Weather Bureau in Alaska has been continued as in former years, there now being 20 meteorological stations which report to the experiment station at Sitka.

The new station which has been opened at Copper Center consists

of a tract of about 775 acres, situated in the Copper River Valley, a little more than 100 miles from the seacoast. This tract of land has been withdrawn from entry by the Secretary of the Interior and set aside for the use of the station.

At the Kenai Station about 15 acres have been brought under cultivation and all the hardy vegetables, buckwheat, oats, barley, and other cereals are readily matured. Additions have been made to the buildings and a beginning made in animal industry. A record was kept of the milk yielded by a cow purchased for the station, which shows that over 29 pounds was produced daily from native pasture grasses during the months of June, July, and August.

At the Rampart Station the work begun in 1901 was confined to the growing of a few varieties of cereals, all of which matured finely. Winter rye sown from seed matured in 1901 successfully passed through the winter and matured a crop of fine grain. These results, attained at a latitude of 65° 30′ N., aid in demonstrating some of the agricultural possibilities of the country. Cooperative experiments have been carried on by Rev. C. P. Coe, who is in charge of the Baptist Orphanage at Wood Island, and these experiments have been conspicuously successful. Winter rye, spring wheat, barley, and oats were matured and a good start made with various tame grasses and other forage crops. Hardy vegetables were produced in considerable quantity, a sufficient amount being grown to supply the 40 members of the orphanage and leave a surplus for sale.

At the Sitka station considerable work has been done in finishing the headquarters building and in enlarging the farm buildings. A small nursery has been established, and several hundred apple trees and current, raspberry, and other shrubs are being grown for distribution when their adaptability has been demonstrated.

During 1904 efforts should be made to reopen and equip the station at Rampart. The conditions here are representative of the largest body of agricultural land in Alaska and embrace many thousands of acres.

At the Sitka station additional buildings are needed, and there is a demand for a scientific equipment, which should include a chemist, a botanist, and an entomologist, with the necessary laboratory equipments for their various lines.

It is highly desirable that work should be taken up with live stock, but at present this can be done only on a limited scale. The special agent in charge of the station has recommended the establishment of a temporary cattle ranch on Kodiak Island with a view of introducing some of the hardier breeds of cattle into Alaska. He believes that the Galloway breed is adapted to the conditions in that territory and that southwestern Alaska is particularly suited to this investigation. For a number of years Congress has appropriated for the introduction of reindeer into the more northern part of Alaska, and it seems possible that in a similar way provision might properly be made for the introduction of cattle into the southwestern grass region.

HAWAII EXPERIMENT STATION.

The work of the Hawaiian Agricultural Experiment Station has been continued along the various lines of investigation previously described. Additional portions of the station land have been brought under cultivation, and additions have been made to buildings, fences,

irrigation plant, etc., as occasion required and funds permitted. A special effort is being made to build up a working library, and the special agent in charge has contributed his private collection as a nucleus for a station library. The necessity for a well-equipped economic library is peculiarly felt in a region as isolated from library facilities as is this station.

During the past year a number of bulletins have been issued, giving the results of investigations which have thus far been carried on. The experiments begun in the previous year on taro rot and potato rot have been continued on an enlarged scale, and the results already obtained suggest the practicability of combating these diseases. One of the most destructive diseases of the taro may be prevented by proper attention to the irrigation water and to the application of suitable fertilizers. The potato experiments have been continued, and it is found that one form of rot may be successfully combated by the thorough use of Bordeaux mixture, and preliminary experiments seem to indicate that a second disease, which is due to a soil fungus, may be prevented to a very great extent by soaking the seed tubers in a solution of formalin and planting them in uninfested soils. These experiments are to be continued for a number of years in the hope that the results obtained in the preliminary investigations will be confirmed.

Formerly, the growing of corn was an important industry in Hawaii, but through careless methods of cultivation and the attacks of insects the growing of this crop has become an uncertain industry. Investigations have been begun by the station in which the effect of deeper plowing, the use of fertilizers, thorough cultivation, and the introduction of new varieties are tested. The preliminary results thus far obtained have given excellent results and two varieties which have been introduced—Leaming and Boone County White—seem to indicate that these varieties are particularly adapted to cultivation in Hawaii and are apparently more satisfactory than the so-called native varieties.

A collection is being made of the grasses and forage plants of the islands, and it is hoped that a bulletin may soon be issued concerning them, which may contain notes on the native and introduced species, together with suggestions relative to their value for different purposes.

The investigations on injurious insects have been continued, and a serious outbreak of a mealy bug on alligator pears was prevented by prompt action.

The station is devoting considerable attention to the subject of fiber plants, and a bulletin has been issued on the sisal hemp in Hawaii and investigations are being carried on with Manila hemp and other fiber-producing plants.

Experiments with tobacco, especially with Sumatra leaf tobacco, grown in partial shade furnished by light cloth, have been apparently very successful and will be continued upon a larger scale. It is believed that there are a number of localities where Sumatra tobacco can be grown under shade at a decided profit.

PORTO RICO EXPERIMENT STATION.

Since the last report from the Porto Rico Agricultural Experiment Station a permanent location has been secured adjoining the city of Mayaguez and the station removed from its temporary location at Rio Piedras. The farm on which the station is situated had not been

in cultivation for some time and a considerable portion of the season was taken up with clearing the land of shrubs and weeds, repairing buildings and roads, constructing fences, digging ditches, etc. As preliminary to planting, a number of acres was sown with general crops in order to bring the soil in condition for experimental purposes and incidentally test the adaptability of the different plants to Porto Rican conditions.

A beginning has been made to establish nurseries of citrous fruits and rubber and tea plants, as well as varieties of mangoes, bananas, and other tropical fruits. Arrangements have been made by which improved varieties of tropical fruits are being secured from different portions of the West India Islands through the courtesy of the commissioner of agriculture for the British West Indies.

Experiments have been commenced to test various fiber plants, and there are now growing at the station Manila hemp, sisal hemp, and a number of species of fiber plants which grow upon the island. Experiments are being conducted to test the value of various leguminous crops for restoring the soil, and thus far velvet beans and soy beans appear very promising. Cowpeas, which had been extensively sown, suffered severely from insect injuries. Alfalfa is also being tested with some promise of success.

The coffee investigations of this station have been continued at the coffee plantation La Carmelita. On this estate 10 acres have been placed at the disposal of the station for experimental purposes, and the effect of different methods of pruning, shading, fertilizing, etc., are being tested.

During the early part of the fiscal year the botanist of the station visited the northeastern part of the island and made a report upon the native forest, which was fast disappearing. Based upon this preliminary survey a recommendation was made to the Secretary of the Interior that a forest reserve be set aside, and in January, 1903, the President proclaimed the Luquillo Forest Reserve of about 25,000 acres.

For continuing the investigations in 1904 the insular government appropriated $2,700. This will be largely expended on permanent improvements and special investigations. Tobacco investigations and a soil survey of the island have been begun, but owing to the small appropriation the work could be but little more than a preliminary survey. It is desired that this work should be continued in cooperation with the Bureau of Soils of this Department, and it is recommended that the present law, which limits the soil investigations to the continental portion of the United States, be amended so as to permit of an extension of the work in both Porto Rico and Hawaii.

The cordial support which has thus far been accorded the station by the insular legislature, together with the interest manifested by planters in requesting its publications and in soliciting specific information, is very encouraging and bespeaks for the station a high degree of usefulness.

INVESTIGATIONS ON NUTRITION OF MAN.

During the last fiscal year the inquiry regarding the food and nutrition of man has been conducted along the same general lines as formerly, and has included studies of the nutritive value and cost of

different food materials in various regions of the United States, special investigations with the respiration calorimeter on the transformation of matter and energy, studies of the changes brought about in cooking, the relative digestibility of different food products, and dietary studies.

Meats, legumes, cereals, fruits, and nuts have been the special subjects of the digestion experiments of the past year. The work with meat has included the study of the influence of cooking, as well as of age, breed of animal, etc., upon digestibility. The experiments with cereals have included the effect of the different methods of the milling of flour upon the digestibility of bread made from it.

Cooking experiments have been made only with meat and have included a study of the effect of cooking upon the flavor, palatability and digestibility, beef being usually used for the purpose. Generally speaking, the meat was cooked in a number of ways, the length of time of cooking, the temperature, etc., varying in the different tests. It was found that the chief loss in weight during the cooking of beef, and doubtless of other meats also, is due to the driving off of water. When beef is pan broiled there appears to be no great loss of nutritive material. When beef is cooked in water from 3 to 20 per cent of the total substance is extracted and found in the broth. The amount of fat thus recovered varies directly with the amount originally present, i. e., the fatter the meat the greater the quantity removed. The amount of water lost during cooking varies inversely as the fatness of the meat, i. e., the fatter the meat the less the shrinkage due to loss of water. In cooking in water the loss of constituents is inversely proportional to the size of the piece of meat.

Dietary studies have been made in several widely different localities, and have included a study of the amounts of food consumed by people of varying occupations, age, sex, and circumstances. The purpose has been to secure data in regard to the kinds, amounts, and costs of food materials under different conditions, to give an opportunity for comparison with the data obtained by investigators in other countries, and to assist in establishing a general dietary standard. As a whole the experiments have given valuable results.

In accordance with the usual plan the investigations have been carried on in cooperation with agricultural experiment stations, agricultural colleges, and other educational institutions in different States, including California, Connecticut, District of Columbia, Georgia, Illinois, Maine, Minnesota, and Tennessee.

Nine dietary studies and thirty-one digestion experiments were made with fruits and nuts, these articles in nearly every case constituting all or almost all of the daily fare. The results obtained warrant the deduction that, as shown by their composition and digestibility, both fruits and nuts can be favorably compared with other and more common foods.

IRRIGATION INVESTIGATIONS.

The work of this branch of the Office of Experiment Stations during the past year has included:

The furnishing of information regarding the requirements and possibilities of irrigation, in both the arid region and the East, to a large number of farmers who either contemplate emigrating to the West or adopting irrigation as an aid to agriculture in the East.

The making of special studies and furnishing expert advice to communities about the methods of distributing water to lessen losses from seepage and evaporation, and about the preparation of plans for draining land in both the arid and humid parts of the United States.

The making of original investigations in order to discover the best methods of handling water and thus promote the largest and best development of the country, and to gather the facts needed to answer the inquiries which come to the Department. These may be grouped under the following heads:

In the acts making appropriations for these investigations Congress has provided that wherever possible the Department should cooperate with agricultural colleges and experiment stations in the several States. Experience has shown that this is a wise provision, as it enables this Department and the State stations to obtain much larger results than would be possible if each carried on its work alone. It is believed that the arrangement is equally advantageous to both parties. In accordance with the provisions of this act we have made arrangements for cooperative work with a number of the experiment stations of the East, where irrigation problems are assuming considerable importance, and with all of the experiment stations of the arid region, except two. In three States special appropriations have been made by the State legislatures to aid in extending this cooperative work. The Department is also receiving appreciated aid from the various State engineers' offices of the arid States.

DUTY OF WATER.

At the outset of these investigations the Department made an extended study of the quantity of water being used in irrigation under existing methods. This knowledge was needed by courts in the establishment of titles to water, by canal companies in planning and operating irrigation works, by farmers in making water-right contracts or in building ditches for themselves, and it was also an indispensable basis for an intelligent effort to bring about a more economical use of water by the improvement of methods, as well as to furnish advice to the large number of persons who each year undertake irrigation for the first time.

The work of the past year and that planned for the future is to promote the adoption of improved methods. It includes the determination of the amount of water needed to give the best results, the time when it should be applied, and the methods of application best suited to different localities and different crops. In this investigation experiments are being made in which the water actually used by plants is being measured. With this as a basis, the additional quantities necessary to supply evaporation and other losses, which are unavoidable under any conditions, can be determined with greater exactness. The same problem is being taken up from the practical side. Experimental fields have been planted. In these fields different quantities of water are being applied to crops where all other conditions are made as nearly uniform as possible. In this way a quantity of water which will produce the largest returns can be determined.

A prominent feature of the reports made by our agents in 1902 is a discussion of the evils resulting from the use of too much water, the swamping and ruining for the present of large areas which were only a few years ago highly productive farms. The first remedy which

suggests itself is to stop using more water than is necessary, and the work of the Department just outlined is for the purpose of determining what is necessary. Farmers can not make these experiments for themselves because they are dependent upon what they grow for a living and must apply enough water to make sure of the crop. It is, therefore, the duty of this Department to make the experiments, and the benefits certain to accrue fully warrant the outlay. The use of water in excess of the needs of crops not only reduces the yields and ruins large areas of fertile lands, but it deprives other lands equally fertile of a water supply. There is an area of approximately 10,000,000 acres now under irrigation, and canals already built cover an added area of at least 5,000,000 acres. Our work in the past leads us to believe that the use of better methods on the areas now irrigated will make possible the cultivation of the added 5,000,000 acres now under ditch with very little added expense for canal construction. Reduction of yields by the failure to use the proper quantities of water is reason enough to justify the work being done on this line, but the damage done by the surplus makes the continuation and enlargement of this work of great public interest.

The work so far outlined deals with those parts of the United States where no crops can be raised without irrigation. Scattered throughout the arid States, and in the regions between the Missouri River and the Rocky Mountains, there are large areas where crops can be raised without irrigation, but where the productivity would be greatly increased by the use of more water and by methods of cultivation which will conserve the supply of moisture which they already have. The agent in charge of our work in Oregon estimates that there are 3,000,000 acres of agricultural land in that State whose products can be greatly increased by the adoption of proper methods for conserving the moisture which falls outside of the irrigation period, and equally good results can be obtained in other States. In Kansas the best methods of utilizing small sources of water supply are being studied, and experiments are being carried on.

SEEPAGE.

Measurements of former years have shown that the losses from canals by seepage are much greater than have been commonly supposed. The Department is carrying on a series of investigations to determine the best means of preventing these losses. Measurements of a large number of canals show that as a rule the greater losses occur in the comparatively short sections. If these sections could be improved, the leakage would be greatly reduced. In many cases irrigators do not make use of more than 50 per cent of the water entering the headgates. The saving of these waters, therefore, means an increase of more than 50 per cent in the available supply, or the doubling of the area irrigated, but the benefits to come from this saving will be more than this gain in crops and in watered area. Seepage water from canals and laterals not only often finds its way where it can not be available for irrigation, but it also prevents the cultivation of large areas of land through the rise of ground water until the land becomes too wet for crops. This also brings up the alkali which has been dissolved and makes the land still further unfit for cultivation. The facts being gathered enable the Department to advise farmers and

canal managers as to the best plans for distributing water to their fields at the least expense and with the least loss.

Leakage from ditches is a very serious question in the extension of irrigation in the eastern part of the United States. It has been found practically impossible to irrigate the sandy lands of Florida by unlined earthen canals, as the water all sinks before it reaches the grounds to be irrigated. There has been a similar experience in both Winconsin and New Jersey, and experiments are being made to determine whether or not some cheap and feasible system of lining canals and distributing water can be found.

DRAINAGE.

Requests from communities for advice about the removal of seepage water have been so numerous during the year that it has been beyond the means of the Department to respond to all of them, and it will be necessary to extend this work in the future. There is a special reason why the Government should lend this aid. The injury to each farmer's land does not come from his own neglect or wasteful use, but from the watering of other areas, which action is being encouraged by the Government, so that the individual settler in many instances is a victim of the country's growth and of a recognized State and National policy.

Numerous requests have also come to this office for advice about agricultural drainage in the eastern part of the United States, and especially in the South and Middle West, where there are large areas of fertile land which, if drained, could be made immensely productive. The drainage of such lands is beyond the means of the individual settler. The public welfare will be greatly promoted by having this work done. Every consideration which justified the extension of aid in the reclamation of arid lands applies with equal or greater force to the furnishing of needed advice about the reclamation and improvement of this overwatered land, because it would have exceptional value. Its fertility has not been exhausted by long cultivation, and it is located where transportation is cheap and where there is direct access to densely populated districts. The farmers are there, the markets are there, and the soil is there. In the aggregate, these swamped areas have a productive capacity equal to four times the State of Illinois, and the inauguration of their improvement takes rank among the important public agricultural movements of the country.

IRRIGATION IN THE EASTERN PART OF THE UNITED STATES.

Irrigation in the humid portions of the United States is proving profitable and is becoming an important factor in the production of certain crops. The irrigation of rice in Louisiana and Texas has added largely to the prosperity of those States and is being rapidly extended. The methods employed differ widely from those used in rice irrigation along the Atlantic seaboard, and the Department is aiding farmers by gathering data as to the quantity of water needed, the best methods of raising it from streams, the cost of pumps, engines, fuel, the construction of laterals, and time and method of applying it. In the South Altantic States rice culture is having to

contend with some troublesome conditions created by the cutting off of the forests on the headwaters of streams. This has filled river channels with the soil washed from the hillsides, and has forced rice growers to contend with a wider fluctuation in streams. A partial investigation of the problems confronting the rice growers in this section has been made to determine the feasibility of providing a supplemental water supply in times of scarcity and also to advise the farmers regarding the best means of protecting their dikes from floods.

An investigation of the requirements of cranberry irrigation is being carried on in cooperation with the State Experiment Station of Wisconsin. This investigation includes a study of both the irrigation and drainage requirements of this crop. The success of the cranberry industry depends upon the proper use and control of water. It must be applied at the right time, and it must be withdrawn quickly at the right time. Until the last few years no attempt was made by cranberry growers in Wisconsin to exercise control over the water. If nature failed to cover the vines at the right time or uncovered them at the wrong time the crop would suffer. The severe drought of 1895 almost destroyed the industry in that State. With its revival better methods are being adopted; dams are being built to collect the surface water; canals are being constructed to carry water pumped from streams. The development of the industry and the extension of the area under cultivation have brought new difficulties. More water is needed, requiring larger ditches. Greater uniformity in the matter of drawing off water is imperative to prevent the operations of one neighbor damaging those below him. Much litigation has been caused by a lack of arrangements for cooperation and by the construction of inadequate works. This calls for more knowledge as to the principles which should govern in this work, which this Department is endeavoring to collect and provide.

The results of the present year, while not conclusive, show how greatly the success of this industry will be promoted by an efficient system of canals for getting the water onto the ground and getting it off. On June 11 of this year there was danger of frost. Those who had proper ditches saved their crops. Those who were not so provided lost them. A conservative estimate of the loss in the Cranmoor and Mather regions places this loss at $25,000. The damage due to improper drains in this region which prevented the removal of the water in time was greater than that from frost, so that from these two items in the two districts there was a net loss this year of over $75,000, a sum which would probably be nearly sufficient to construct a system of canals to meet the demands of both districts.

The severe drouth which prevailed in the New England and North Atlantic States during the early part of the present summer not only showed the importance of irrigation to market gardeners and others growing high-priced products in this part of the country, but gave an excellent opportunity for observing the effects of irrigation where it was made use of. The facts regarding the operation of a considerable number of private irrigation plants have been collected and will be published for the information of others wishing to undertake similar work. There were also carried on in New Jersey some systematic studies of the effect of irrigation upon asparagus, other vegetables, and small fruits, and on the sandy lands in the southern part of the State.

FOREIGN STUDIES.

The law requires that this Department shall investigate irrigation methods and laws of foreign countries. A report on Egyptian irrigation has been published, and during the past year a study of the methods of operating canals and distributing water among farmers in Italy has been made. Both of these have shown that foreign countries have many ideas and practices which we can study to advantage, and these studies of foreign systems should be continued until our farmers are informed as to the methods of every country in the world where irrigation is practiced.

AGRICULTURAL ENGINEERING.

Attention has been previously called to the importance to American agriculture of bringing about improvements in our practice along a number of branches of engineering. But so pressing has been the demand for investigation relating to irrigation that it has not been possible, with the funds at the command of the Department, to do any considerable amount of work in other lines of agricultural engineering. The studies in drainage, apart from those relating to irrigation, which it has been possible to make, have been of great value to a number of districts in the East, and these should be extended.

The studies of pumping should also be extended, in order to answer more definitely the many inquiries which are coming to the Department for information and advice. Already thousands of farmers are pumping water for irrigation and thousands of others are thinking of doing so. They write to this Department asking the amount of water required and the size and kind of pumps necessary to furnish it. It is certain that irrigation by pumping will greatly increase in the future, and the money value to farmers of having pumps operated efficiently will be proportionately enhanced. Pumping is also being used to relieve land which has been injured by seepage, and altogether this field is one of the most promising in which we are engaged, and nothing should interfere with continued work on this line.

While the study of power is being made primarily with relation to its use in running pumps, the information collected will prove useful in other lines of farm work. The long-distance transmission of electricity has made it possible to utilize the power of streams so cheaply that it can be profitably applied to many classes of farm work. Competition makes it necessary for our farmers to adopt every means of cheapening production, and the use of this power for operating farm machinery promises much in this line. Power has been largely used on great ranches, but has not been adapted to the needs of the man who is farming on a small scale and doing his own work. The work now being done by this Department is of especial value to this class of home-making farmers, as it will help to put them in a position to compete with those who can take advantage of the economies made possible by doing things on a large scale.

Closely related to this has been the growing interest in a number of our strongest agricultural colleges in the development of courses of instruction in farm mechanics. The increasing use of large, complicated, and expensive machinery in connection with farm operations has led to a demand on the part of the students attending the agricultural colleges for definite instruction regarding the construction and use of such machinery. Important problems regarding the further application

of steam, gasoline, electricity, and other kinds of power to farm purposes are also being brought home to these institutions to solve in the interests of our farmers. The manufacturers of farm machinery, realizing that experts trained in the science and art of agriculture as well as in mechanics and engineering would make their most efficient helpers, are beginning to look to the agricultural colleges for such men. The colleges attempting to establish courses in farm mechanics and other lines of agricultural engineering are immediately made aware of the fact that the data for the scientific and pedagogical basis of such courses are very meager, and they are therefore looking to this Department to aid them in instituting investigations to supply this information. Since it has seemed to this Department that this field of investigation was clearly within the scope of existing law, it has begun to aid the colleges along this line. With our present resources only a very limited amount of work in this line can be undertaken, and I have therefore recommended that $10,000 be appropriated to enable this Department to extend its operations in agricultural engineering, especially on the application of power to farm machinery.

In order that the work of this Department in lines of agricultural engineering other than irrigation may be more definitely recognized, and organized on a more permanent and satisfactory basis, I recommend that Congress change the wording of the appropriation act so as to make the general title of this division of our work "Irrigation and Agricultural Engineering."

OFFICE OF PUBLIC ROAD INQUIRIES.

The National Good Roads Convention held at St. Louis, Mo., April 27 to 29, 1903, in connection with the opening of the Louisiana Purchase Exposition, was probably the most important meeting of the kind ever held in the United States. It brought together a greater number of influential citizens than any previous road convention. Addresses were delivered by the President of the United States, several governors of States, and members of Congress, besides prominent men engaged in agricultural and commercial pursuits, railway transportation, and journalism.

The work of testing the chemical and physical properties of road-building materials has been continued by the road-material laboratory, which is conducted in the Bureau of Chemistry in cooperation with the Office of Road Inquiry.

COOPERATIVE FIELD WORK.

The cooperative field work of the Office deserves special mention. Work of this kind usually results from an invitation extended to the Director by local or State authorities, an agricultural experiment station, or a good roads association. The Department furnishes only the services of its road experts. The materials are supplied, and the expenses of the work paid, by the other factors in the cooperation. The machinery employed is usually furnished free of charge by the manufacturers, who thereby secure an advertisement of their wares; and the railroad corporations usually transport such machinery free on account of their interest in road improvement as a means of developing the country tributary to their lines. The end in view is the construction of a short section of object-lesson or experimental road.

Such work furnishes opportunity to test local road-building materials, and gives the people of the locality an object lesson in methods of preparing the material and constructing the road; and the finished road serves to teach the worth of a good hard road to all who travel over it. In nearly all cases the value of such work is greatly enhanced by the holding of a convention while the work is in progress. This brings together a large number of persons, who not only secure the benefit of the object lesson, but who listen to addresses on all phases of the road question.

Cooperative field work of the kind just described has been carried on to a greater or less extent during the last five years, and its practical value has been amply demonstrated. It certainly yields a maximum of good results at a minimum of expense to the Government. The Director of the Office has recently secured reports from many localities where experimental road work has been done, and they uniformly show that the work was well done and that the object-lesson roads built led to a general improvement of the roads in those localities. During the past year more cooperative field work has been done than in any preceding year, and the demand for Government aid of this kind is greater than ever before.

For greater convenience and efficiency in carrying on the field work of the Office, the country has been laid off into four main divisions, with a special agent in charge of each.

GOOD ROADS AND RURAL FREE MAIL DELIVERY.

The intimate relation which exists between good country roads and rural free delivery of mail can not be too strongly emphasized. Communities which would enjoy the latter must make and maintain the former. In many instances bad roads have prevented the extension of rural free delivery to communities where it was greatly desired, and in some cases have caused suspension of routes already in operation. The desire for extension of the service should, and doubtless will, act as a powerful stimulus to road improvement in many localities.

The work of the Office of Public Road Inquiries appears to be no longer of a tentative character. Year after year it assumes increased importance and wider scope. That it will be a permanent feature of the Department's work hardly seems open to question.

DIVISION OF ACCOUNTS AND DISBURSEMENTS.

The extension and rapid growth in the work of this Department necessitates an increase in the estimates for each year. These estimates are prepared in the Division of Accounts and Disbursements and transmitted to the Congress through the Secretary of the Treas ury and all expenditures are made under the supervision of that Division. The appropriations for the fiscal year ended June 30, 1903, including $510,000 for deficiencies, were $5,013,960, an increase of $1,091,231.54 over the preceding year. The expenditures during the year amounted to $4,296,882.60, leaving a balance of $717,077.40, but, the greater part of this sum is covered by outstanding liabilities.

All accounts for the fiscal year 1901 having been settled, the unexpended balances of appropriations for that year, amounting to $65,127.50, were covered into the Treasury on June 30, 1903.

There was received and deposited in the Treasury the sum of $12,803.56. Of this amount $4,026.69 were received from the sale of American products in Europe, $382.75 from sales of agricultural products of the agricultural experiment station in Hawaii, $782.45 from the station in Porto Rico, and $548.15 from sales of experimental shipments of fruit to Europe.

The amount paid for rent of buildings in the District of Columbia for the use of the several branches of the Department was $21,700. The amount appropriated for the same purpose for the current fiscal year, 1904, is $27,900, an increase of $6,200.

DIVISION OF PUBLICATIONS.

The work of the Department of Agriculture in all its branches is necessarily reflected in the work of the Division of Publications. As all the other bureaus and divisions contribute to the acquisition of information, so the Division of Publications is the channel for its diffusion. Therefore, no possible enlargement of the work of the Department in any particular branch can be conceived of which does not ultimately add to the work of the Division of Publications. It is not within the province of its chief to restrict its work, but only to direct and control it to the best of his ability and with the means at his command. These facts explain quite logically the continued growth in the work of this Division.

Until last year the largest number of publications issued in any twelve-month period was 757 in 1902. The total number of publications issued during 1903, however, was 938. Of the publications issued in 1902, 355 were new. The new publications issued in 1903 amounted to 375, showing that the bulk of the increase in the number of publications issued consisted of reprints, which in turn indicates a continued and pressing demand for the Department publications. While the new publications show but a small increase in number, the number of pages they contain shows an increase of 17 per cent over 1902. The total number of copies of all publications issued during the year aggregated not far from 12,000,000.

The publications known as Farmers' Bulletins seem to satisfactorily supply a widely felt want. Of the total number of copies of all publications issued during the year nearly 7,000,000 were Farmers' Bulletins, and of these nearly 4,000,000 copies were distributed, as provided by law, under addressed franks supplied by Senators, Representatives, and Delegates.

In spite of the generous supply of publications, it is constantly necessary to refuse requests, owing to the editions being exhausted and means lacking to furnish a further supply. Under these circumstances I have found it desirable to restrict free distribution abroad to Government and other public institutions and to a few persons engaged in lines of work analogous to our own and actually cooperating with us.

The figures showing the number of publications issued and distributed by the Department would suggest to casual observation that the number was amply sufficient to supply all possible demands. Such, however, is far from being the case. A careful consideration of the applications received afford conclusive evidence that only a comparatively limited number of the nearly 7,000,000 farms in the United States are reached by the publications of this Department. This is a matter of regret, as

the full value of the information acquired by the Department can unquestionably be realized only by a prompt and widespread diffusion to all those who might be benefited by it. It is a striking evidence of the general appreciation of the information the publications of this Department contain that over 30,000 copies were sold by the Superintendent of Documents in the face of the enormous free distribution, and that official has moreover declared that the number sold would be twice as great were he able to supply the demands. This suggests the desirability of setting aside, to defray the expense of reprints, the sums received by him for publications sold through his office.

The conservative course recommended by yourself in the matter of illustrations has been carefully followed, the rule adopted being to exclude all illustrations not necessary or at least essentially helpful to the understanding of the text. It is impossible for this Department, for reasons sufficiently obvious from what has already been said, to further restrict the output of publications. In view of the increase in the work of the Division of Publications and the causes which promise its continuance in the future, I have felt constrained to recommend some increase in the appropriations for its use.

THE LIBRARY.

The work of the Library increases from year to year with the growth of the Department, and with increased appropriations it is better able each year to meet the varied demands made upon it. The collection of books and pamphlets now in the Library numbers about 80,000, and contains many books and periodicals found in few, if any other, libraries in the country. Agricultural workers in all parts of the country look to this Library more and more for assistance in the way of loans of books, verification of references, and preparations of subject lists.

ACCESSIONS.

A larger number of purchases have been made during the past fiscal year than in any year previous. Many new scientific serials have been added to the list of subscriptions, and the list of general agricultural, technical, and scientific periodicals acquired by gift and exchange has been largely increased. The present policy of the Department in the distribution of its documents enables the Librarian to arrange exchanges with many foreign as well as American scientific institutions and societies whose publications form valuable additions to the Library.

TECHNICAL WORK.

The Library has continued the publication of its quarterly bulletin of accessions. The recently adopted subject arrangement of the bulletin has proved to be an added convenience for reference use. Beginning with December, 1902, catalogue cards for current accessions to the Library have been printed at the Library of Congress. Extra copies of these printed cards can be purchased at small cost on application to the Librarian of Congress. A reprint of the index cards for the Yearbooks and the Farmers' Bulletins is in progress to meet the demands from the smaller libraries in the country for indexes to these popular

publications of the Department. Provision has also been made for extending this index work to include index cards for some of the most important agricultural periodicals. During the past year there have been requests from several agricultural colleges and experiment stations for suggestions and aid in reorganizing their libraries. Assistance of this kind has been given whenever practicable, and the Department will continue such aid to further the organization and development of agricultural libraries.

NEW BUILDINGS FOR THE DEPARTMENT.

It is gratifying to announce that Congress, at its last session, authorized the expenditure of $1,500,000 for the erection of new buildings for this Department. Two hundred and fifty thousand dollars was appropriated to inaugurate the work and as soon as the money became available steps were taken to secure the necessary plans and specifications. At the outset, some difficulties were met in the matter of reaching satisfactory conclusion with the architects. These matters were not finally settled until early in September of this year, when the contract for the preparation of plans and specifications was awarded to the firm of Rankin, Kellogg & Crane, architects, of Philadelphia.

The Department is now occupying 137,963 square feet of net floor space, 75,771 square feet of which is in rented buildings. In order to accommodate the present needs of the Department alone this amount of space would have to be increased fully 25 per cent. The Department of Agriculture is different in its requirements, so far as buildings are concerned, from other branches of the Government. Our work is largely of a research nature. Laboratories, therefore, are essential and form a considerable portion of the room required. A committee of Bureau chiefs in the Department, consisting of Doctors Galloway, Salmon, and True, has given careful consideration to the varied needs and have made recommendations, which I approve, that the best interests of the Department will be subserved by providing for a series of buildings connected with pavilions in such a way as to make practically one harmonious structure. The chief advantage of this plan is that it can be laid out in such a way as to be added to indefinitely from time to time, as the needs of the Department grow. These ideas formulated by the committee have been further developed by the architects, with a result that a series of buildings has been designed, the central feature of which is an administrative structure. Grouped about this are laboratory buildings to be used by the large bureaus in their research work.

The scheme, as a whole, provides for the erection of ten buildings, all suitable for the class of investigations which the Department must necessarily carry on. The amount authorized by Congress will suffice for the erection of three of the laboratory buildings, but it will not be sufficient for the erection of the administrative structure. The three buildings will have in them floor space of 100,000 square feet and will enable the Department to comply with the law, in so far as bringing within these structures all those branches of the Department that are now paying rent. The three buildings contemplated will be completed within the appropriation authorized according to the estimates secured at the present time.

CRISIS IN COTTON PRODUCTION.

The invasion of the cotton boll-weevil has been a special menace to our cotton crop, and has done more than anything else to awaken widespread apprehension as to the future of this most important crop. The boll-weevil first appeared in the State of Texas in 1894, and from that time on has been under observation and investigation by the Department through its Division of Entomology. It was not until 1902, however, that this branch of the Department was able to undertake anything like thorough and systematic work in the matter of studying this very destructive enemy of cotton. In 1903 the scope of the work was further enlarged, an appropriation of $20,000 being made in the Division of Entomology for the investigations. Aside from this work the Bureau of Plant Industry has, during the past year, been carrying on considerable work with a view to securing, if possible, early and resistant varieties by breeding and selection; and has been conducting some more or less general experiments in the matter of crop diversification at special points in Texas. It has also been engaged in distributing a considerable quantity of cotton seed of early maturing and promising sorts.

The work of the Division of Entomology has shown conclusively the value of good cultural methods, the planting of early-maturing varieties, and the destruction of weevil-infested material, this conclusion having been reached only through the careful and detailed studies of the life history and habits of the insect. The demonstration work along these lines, which the Division carried on the past year, has been exceedingly promising, as it has been shown that cotton can be grown in remunerative quantity, despite the presence of the weevil. Notwithstanding what has been accomplished by the Department, however, the fact remains that the boll weevil is constantly spreading north and east, and it is probably only a question of time when it will reach all of the cotton-growing States. Thus the country is confronted with a very grave problem, as the invasion of this insect must necessarily mean a complete revolution in present agricultural methods. During a recent visit to some of the Southern States considerable time was spent in the weevil-infested district, and from the facts gathered in this way I am convinced that energetic measures must be adopted to meet the present emergency. After thoroughly canvassing the situation with representative men in Congress and with others, I am of the opinion that a cotton investigation fund should be appropriated and set aside for immediate use in connection with this most serious problem. In order to make the work comprehensive and thoroughly effective, I am of the opinion that a sum not less than $500,000 should be made immediately available for this purpose, the same to be expended under the direction of the Secretary of Agriculture, in such manner as will give the most immediate practical results. As to the problems which might be handled by the Department with such a sum available, I would respectfully call attention to the following:

RECOMMENDATIONS.

1. CHECKING SPORADIC OUTBREAKS OF THE WEEVIL.—It would seem highly important that some action be taken looking to the checking, if practicable, of sporadic outbreaks of the weevil in the territory

immediately adjacent to that now infested. This could best be accomplished by the organization of a corps of competent entomologists and could be carried on in cooperation with the State authorities. In order to make this work thoroughly effective it will be necessary for the States interested to enact proper legislation. This is a matter that could be handled and guided by those in authority, working under the direction of the Secretary of Agriculture.

2. DEMONSTRATION WORK TO SHOW THE VALUE OF IMPROVED CULTURAL METHODS BY WHICH FARMERS CAN PRODUCE FAIR CROPS IN SPITE OF THE WEEVIL.—This is the most promising field for immediate relief, and owing to the fact that the weevil is so far confined to Texas, the work here outlined would necessarily be limited more or less to this State, although regions in adjacent territory should also have such investigations carried on in them in order that the people may become enlightened in advance of the insect's ravages. The object and scope of the work would be to show by actual demonstration experiments the value of better cultural methods, the value of early maturing varieties, and the value of and necessity for complete and thorough destruction of all infested material. To carry out this work thoroughly and effectively would require a corps of men familiar with cultural conditions, and who have the knowledge and ability to direct the necessary specific work that might be ordered by the Secretary of Agriculture. Legislation would be required in this case, also, to enforce the destruction of infested material; but, under proper organization, this could be brought about.

3. WORK HAVING FOR ITS OBJECT THE PRODUCTION OF NEW, EARLY, AND IMPROVED VARIETIES OF COTTON.—The value of early varieties has been demonstrated, but most of them have serious drawbacks in that they are poor yielders and the lint drops out easily during storms. These matters may be corrected by proper breeding and selection, and one of the important problems would have for its object the taking up of this work on a systematic scale, to the end of securing sorts which would not only be early, but would be storm-proof and resistant.

4. STUDIES OF COTTON DISEASES.—While the boll-weevil is mainly in the public eye at present, the fact remains that other serious pests of cotton cause great losses annually. It is natural to attribute all losses at the present time to the insect in question, whether these losses be from other insects, diseases, floods, droughts, or whatever source. Reliable studies indicate that the loss in Texas alone from the so-called root-rot disease will, in all probability, aggregate several millions of dollars annually. This and other diseases should be thoroughly studied, and corrective measures should be adopted.

5. COTTON INSECTS.—What is said of cotton diseases is also true of cotton insects (especially of the boll-worm) other than the boll weevil. These should all receive careful attention, and practical experiments should be carried on with a view to lessening the injury caused by them.

6. INTRODUCTION OF NEW CROPS.—The urgent necessity for the introduction of other crops which will take the place of cotton can not be too strongly emphasized. Cotton, of course, should be grown, but the time is evidently at hand when a concerted effort should be made to bring about a change in Southern agricultural conditions in the

direction of greater diversification. This is recognized now as a vital question in the South. In many sections already the yield of cotton is barely profitable, so that, when the reduction due to the boll-weevil and other pests is taken into account, it will be necessary to abandon cotton growing altogether; while the decreased yield in the best districts of the cotton-growing sections renders it more important that other crops should be grown. Such crops as alfalfa, sorghum, Kafir corn, and cereals of various sorts should all receive attention, not only for silage, pastures, and winter forage generally, but for green manures as well.

7. STUDIES AND EXPERIMENTS IN CONNECTION WITH METHODS FOR THE DESTRUCTION AND CONTROL OF THE BOLL-WEEVIL, AND OTHER COTTON INSECTS.—It would seem highly important that the Government should take cognizance of the many devices which are being placed on the market for combating the weevil and other insects. This is necessary, as much for positive as negative results. Hundreds of devices and nostrums are offered to the public, and people are led to spend money for them. The Government should be in position to determine, once for all, the value or nonvalue of such devices, and thus be able to definitely and positively advise on all matters of this kind. Aside from this, the Government should take the matter of mechanical devices under thorough consideration, and should encourage, by the utilization of mechanical experts, the construction and use of everything which gives promise of practical value.

8. STUDIES OF ENEMIES OF THE INSECT.—While the studies of the enemies of the insect have had, so far, no practical result, there is no doubt that this work should be continued, and everything in the nature of enemies, whether they be predaceous or parasitic insects, birds, fungus parasites, or others, should receive careful attention.

9. SECURING AND DISTRIBUTING SEED OF COTTON KNOWN TO HAVE SPECIAL VALUE FOR EARLINESS AND ABILITY TO RESIST THE WEEVIL.—Systematic action should be taken in the matter of securing from every source available seed of promising varieties and thoroughly testing them in the weevil-infested district. In addition to this there should be a systematic endeavor to bring together desirable varieties from all available sources for advance trials in the sections where the insect is likely soon to make an invasion.

10. GENERAL PROPAGANDA.—Under this head there should be organized a competent corps of efficient workers, who could, with the cooperation of the agricultural colleges, farmers' institutes, State boards of agriculture, and all such organized bodies, bring to the attention of planters everywhere the latest results as to methods of meeting the present emergency.

To carry out the foregoing work effectually, it is believed that the best results will be secured by a separate organization. It will be seen that the two branches of the Department primarily interested in this matter are the Bureau of Plant Industry and the Division of Entomology; and their officers and men would be in position to effect the proper organization and to direct the main features of the work. I would, therefore, respectfully recommend that, if the amount already mentioned be set aside as a cotton investigation fund, the Secretary of Agriculture be authorized to take such steps in the perfecting of a

proper organization for handling the work as, in his judgment, may be best. Owing to the very nature of the investigations, and the fact that they will involve most thorough and far-reaching scientific work, the management of the general plans must necessarily rest with the Department. It is believed that the work can be strengthened by securing the advice and cooperation of one or two thoroughly practical men in the States most directly interested, viz, Louisiana and Texas. The Secretary of Agriculture, however, should have full authority to organize the work for the sole object of securing, as already indicated, the most immediate practical results.

In order to more effectually handle the problems which must necessarily fall to the work of the Division of Entomology, I have already recommended in my estimates that this important branch of the Department be made a bureau. The work that it has done in the past, especially in the field in question, certainly justifies this action; and I most earnestly recommend that this matter be given primary consideration in connection with the entire problem. It is very desirable, furthermore, that the fullest cooperation be effected by the Department with the experiment stations in the respective States, where the more important work will be conducted. This is especially true of Texas, where the Agricultural College is doing everything in its power to aid in the matter, but where it is more or less handicapped by lack of proper facilities and funds.

The fund recommended to be set aside for the purposes mentioned, and used in accordance with the plans outlined, will give the Department such liberty of action as the exigencies of the case demand. An industry which brings to the country an annual income of something over $500,000,000 is threatened, and the time is at hand for energetic action. I again, therefore, most earnestly renew my recommendations for the means and authority to carry out the plans as herein set forth.

Respectfully submitted.

JAMES WILSON,
Secretary.

WASHINGTON, D. C., *November 28, 1903.*

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U. S. DEPARTMENT OF AGRICULTURE.

Report No. 77.

ALFALFA AND BEEF PRODUCTION IN ARGENTINA.

BY

FRANK W. BICKNELL,
SPECIAL AGENT.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

ARGENTINA: PROVINCES, RIVERS, RAILWAYS, AND PRINCIPAL CITIES.

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ARGENTINE TERMS AND MEASURES USED.

For the convenience of the reader in the United States all terms and measures employed in this report have been converted into terms employed in the United States, except where otherwise expressly stated. Some terms and expressions in use in Argentina, or having a special meaning there, are occasionally used, and these are herewith explained.

Money.—All expressions of value, unless otherwise stated at the time, have been converted into United States currency. The Argentine gold dollar is worth $0.965 in United States currency. The paper dollar, which is the general circulating medium, is worth about 44 cents of our money. All transactions in Argentina are in paper money unless gold is specified.

Metric system.—The metric system of weights and measures is in use in Argentina, and is the only legalized system. Some of the old Spanish or local terms are still in use, however, especially in the country. The kilo, abbreviation of the word kilogram, is the standard unit of weight, and is equal to 2.2046 pounds avoirdupois.

Land measurements.—The official unit of land measurement is the hectare, equal to 2.471 acres. A "square" of land is equal to 4.17 acres, and this old term is in very general use. The common understanding of the "league" of land is a square league, equal to 6,672 acres. A kilometric league of land, the official measurement, is equal to 2,500 hectares, or 6,178 acres.

Estancia and estanciero.—An estancia is, primarily, a stock ranch, and the owner and operator is an estanciero. But the estancia may include other things. It may also be a breeding establishment or that only. It may deal in cattle, horses, or sheep, or all three, either for sale in the open markets for beef or mutton, or for feeding stock, or for breeding purposes, or all these. Cereal production and hay making may be added to these, and sometimes this may be the most important part of the estanciero's business. So in translating it is impossible to say in a single word just what is meant. In this report the words estancia and ranch have been used synonymously, also the words estanciero and ranchman.

Chacra and chacarero.—A chacra is a farm on which cereals or other crops are raised, as distinguished from the estancia or stock ranch. The chacarero is the farmer or man who operates a chacra.

Camp.—In Argentina people speak of the country outside of the cities as the "camp." They say, "I am going to the camp," where we would say, "I am going to the country." The word is also used in speaking of the land—as, for instance, "My camp is in good condition," or "The alfalfa camps are holding out well."

Alfalfar.—An alfalfa field.

Frigorifico.—A meat-packing establishment where cattle and sheep are slaughtered and the carcasses either frozen or chilled for export.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., January 8, 1904.

SIR: I have the honor to submit herewith a report upon the influence of alfalfa upon beef production in Argentina, to which I have added some late information concerning the market for pedigreed stock in that country. The opportunity for our breeders was never as promising there as it is now. I therefore respectfully suggest that this report be printed for the guidance of the breeders of the United States who may wish to enter that market. Argentines are very eager to secure first-class breeding stock, and the English breeders who have been supplying the demand have found the business highly profitable.

This report is supplemental to my bulletin on "The animal industry of Argentina," printed as Bulletin No. 48, Bureau of Animal Industry.

Acknowledgment should be made to the following-named gentlemen in Argentina, whose intelligent and willing cooperation made this report possible: John Benitz, Glynne Williams, Eduardo Bullrich, William O. Benitz, Henry B. Coffin, Leonardo Pereyra, Ronaldo Tidblom, Alfredo Benitz, Dr. Enrique Fynn, jr., Arturo Bab, Adolfo Aymerich, Alfredo Sanders, J. Charles Pearson, Latham Hall, Nicolas Calvo, and C. A. Roberts.

Respectfully,

FRANK W. BICKNELL,
Special Agent and Agricultural Explorer.

Hon. JAMES WILSON,
Secretary.

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ALFALFA AND BEEF PRODUCTION IN ARGENTINA.

ALFALFA GROWING AND ITS RELATION TO CATTLE RAISING.

INTRODUCTION.

Without alfalfa Argentina would occupy an unimportant place as a beef producer in the markets of the world. Alfalfa has redeemed to profitable use millions of acres of Argentine land that would otherwise be unproductive. Alfalfa sends the Argentine steer to market a year younger than when the native grasses were relied upon exclusively. In many places, especially in the northern part of the country, it has made money for the small farmers, or "colonists," who have cut it and sold it for hay for export or for domestic use. Cattle raisers have learned its value in a dry, cold winter, when the pastures have failed, and but for the alfalfa hay, put up by the provident against such an emergency, hundreds of thousands of cattle would starve. But this marvelous forage plant is valuable in Argentina chiefly because it gives a rich fattening pasture on land that is otherwise of small value. Alfalfa is the only plant that will send its roots down deep enough to get the moisture necessary to growth.

GROWING OF ALFALFA AND PRICE OF LAND.

It is the ambition of nearly every ranchman, or estanciero, to get as much of his place into alfalfa as possible, and the area of alfalfa pasture is increasing enormously every year. In some sections it is still in an experimental stage and in others it has proved a failure, at least for pasturage; because "tosca," a limestone formation, is too near the surface of the ground or because native summer grasses overcome it. But the failure of wheat in the northern part of the Province of Santa Fe (Pl. I, frontispiece) has driven small farmers to turning their wheat farms into alfalfa fields or to moving to another part of the country, either to raise cereals under more favorable conditions or to go into alfalfa where experiments have shown that it will succeed. Farmers in the same region who, instead of putting all their land into wheat or flax, have planted alfalfa and corn and raised cattle have done well. As soon as a brief experiment demonstrates the adaptability of a new region to alfalfa, there is a grand rush to get in.

Land jumps up incredibly in value; thousands of acres often change hands several times in a year, with valuations doubled at each exchange. This was the case in 1902 with lands in the central part of the Province of San Luis, 425 miles by rail west of the city of Buenos Aires. It was found that alfalfa would grow very well there, and the lands were wanted by men owning large cattle ranches (Pl. II) in the Province of Buenos Aires, where they could not afford to fatten their steers. They wanted cheap alfalfa lands to which they could send their young steers to fatten and on which they could breed others.

Alfalfa for pasturage for fattening cattle is not grown so much in the Province of Buenos Aires, where land is most valuable and the country most settled. There are several reasons for this, the chief ones being that they have good, rich, native summer and winter grasses (Pl. III) and do not need the alfalfa so much, and these native grasses exterminate alfalfa in a few years. Besides, the winters are longer and colder in Buenos Aires than in the alfalfa regions north and northwest, and land for alfalfa is much more expensive in "the Queen Province," as Buenos Aires is called.

METHODS AND PROFITS IN GRAZING ALFALFA.

The system now generally coming into vogue is to raise feeders in the Province of Buenos Aires and in the far north, to be taken to the alfalfa camps (fields) to fatten. In the south of Buenos Aires the winters are so long and severe that it is not the rule to fatten steers, but to sell them at 2 years of age to go to the alfalfa camps for eight to twelve months' feeding. Estancieros in southern Buenos Aires say that unless steers are housed there they have very little chance of becoming fat. Still I have seen some very good looking steers, Polled Angus and Shorthorn, in this neighborhood, 20 miles east of La Colina, which is a little less than 300 miles south of the city of Buenos Aires.

The following is the opinion of an alfalfa ranchman of wide experience and notable success in the Provinces of Santa Fe and Cordoba:[a]

> You can buy a league (6,672 acres) of virgin land for $11,000. or $1.65 per acre and, by spending as much more in putting it into alfalfa, have a ranch that will carry 3,000 cattle and keep them practically fat all the year round, with very little risk from drought or severe winters. These provinces that grow alfalfa so easily (Cordoba, Santa Fe, San Luis, and western Buenos Aires) are the future

[a] Mr. John Benitz, who went from California to Argentina thirty years ago, and with his brothers, William and Alfred, has been very successful with alfalfa and cattle. On their home estancia, "La California," about 70 miles northwest of the city of Rosario, they were the pioneers in the planting of alfalfa, and were among the first, if not the first, to have a league of it. The one quoted is now working about 60,000 acres in alfalfa in southern Cordoba.

BRICK BARN FOR CATTLE, GRAIN, AND HAY, NORTHERN BUENOS AIRES.

Report No. 77, U S. Dept. of Agr.

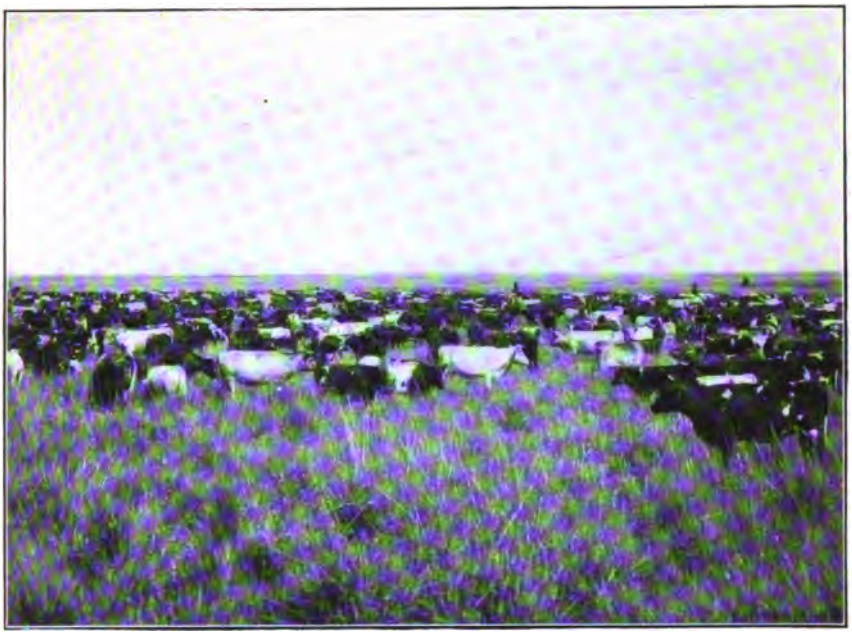

FIG. 1.—HERD OF 5,000 GRADE DURHAM COWS ON NATIVE GRASS, 160 MILES WEST OF THE CITY OF BUENOS AIRES.

FIG. 2.—SHORTHORN COWS AND CALVES ON NATIVE SUMMER GRASS, NORTHERN PART OF THE PROVINCE OF BUENOS AIRES.

grazing lands of the Republic. It is astonishing what large areas are taken up every year and turned into alfalfa, to be stocked with the best cattle to be purchased in the Province of Buenos Aires. Cattle develop here better than on the finest natural grasses of the Province of Buenos Aires.

THE REGION OF ALFALFA GROWING.

Alfalfa is grown all over the Province of Santa Fe, except in the extreme northern part, north of latitude 30° south; in all the Province of Cordoba south of the city of Cordoba and in mountain valleys north of the city; in most of the Province of San Luis, where it is fast increasing; in the northern part of the Territory of the Pampa; more or less, either for hay or grazing, in the entire Province of Buenos Aires, especially in the west and north (Pl. IV, fig. 1); to some extent in the Province of Entre Rios, where it has not done so well; in the irrigated and fertile valleys of the rivers in the southern territories of Rio Negro, Neuquen, and Chubut to a limited extent; and small areas in the northern provinces of Mendoza and San Juan. It is at its best in southern Cordoba, Santa Fe, San Luis, and western Buenos Aires.

SEASON AND METHODS OF SEEDING WITH ALFALFA.

Most of the seeding with alfalfa in Argentina is done in the fall, in the months of March and April,[a] where it is sown alone, or two or three months later where sown with cereals. The difficulty of preparing large areas for sowing early in the fall operates to postpone the sowing, as the great saving in expense leads farmers, especially estancieros, or large stock farmers, to sow with wheat or flax, or sometimes barley or corn. Harvesting and thrashing cereals are hardly finished during January and February, and hauling to market is not done till the end of February or well into March. This makes it difficult and expensive to get the land plowed for alfalfa sowing in March or April. Besides, the land is likely to be too hard to plow till after the first fall rains. There is no doubt, however, that the best results are secured by sowing at this time and without the nurse crop. The heat of the summer is over by the last of March, and the alfalfa plants get a good start before frost and the dry winter months of the northern region. In the spring the alfalfa is strong enough to smother any grasses or weeds that may come up. This is the general opinion over the country, though one very successful alfalfa grower in the Province of Buenos Aires, not far from the city, sows in August or September. His land is more sandy and probably does not encourage the growth of weeds to the extent that stronger soils do.

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[a] It must be remembered throughout this report that the seasons are those of the southern hemisphere, the reverse of seasons in the United States.

SOWING ALFALFA WITH A COVER CROP.

A great majority of the ranchmen of Argentina who raise alfalfa consider the advantages of sowing it in June or July with wheat or flax to be so great that a very large part, probably three-fourths, is sown that way. The objection to this plan is that the plants do not get a good start in this sometimes dry and always cold season; that the wheat chokes the alfalfa back until after the wheat is cut, when the rain and heat stimulate weeds that sometimes overcome the alfalfa. The same amount of seed sown without a nurse crop will give more and better plants than with it.

But when a ranchman has a large area that he can get into alfalfa in two or three years without any expense to himself, the land paying him an income in the meantime, he is very likely to adopt that method, though it does not give quite as heavy a stand of alfalfa at first. For the man who is short of working capital there is no other practical way. The system prevails all over the country where cereals and alfalfa do well in the same region, but is less followed in the south of Cordoba, the best alfalfa country, and not at all in the newer regions in San Luis. Ranchmen (estancieros) in the Province of Buenos Aires, who have large areas in native grasses, are turning the land over to colonists, or renters, who raise wheat on it for two or three years, under a contract that requires them to sow alfalfa with the wheat the last year, the seed furnished by the landowner. Thus he gets the best results with wheat, and the land is handed back to him covered with alfalfa.[a]

So much of this has been done that it has led many cattlemen to the opinion that agriculture is only transitory, and that the future of Argentina depends upon cattle and alfalfa; but they admit now that they must have corn to finish their steers. An English estanciero, Mr. Glynne Williams, who has a large place near Coronel Suarez,

[a] Señor Ronaldo Tidblom, Director of the Argentine Bureau of Animal Industry, gives the following account of an operation of his own as a practical estanciero:

"I have sown 42,000 acres of camp with wheat and alfalfa in the south of Cordoba and Santa Fe, where I could only keep 1,200 breeding cattle per kilometric league (6.178 acres), with a gross profit of $308,012, with a total expense of $208,741 and net profit of $99,271, said camp having now a carrying capacity of from 6,250 to 7,000 breeding cattle per kilometric league. The pastoral grass is burned, the land plowed and well harrowed in October, November, December, January, and February; it is plowed deeply a second time in May, June, or July, harrowed, the wheat seeded thin, and again harrowed; the alfalfa is then seeded at 22 pounds per acre, the land harrowed with chain harrows and then rolled. The alfalfa germinates more or less at the same time as the wheat: the wheat is harvested in December and cut as low as possible, and the land is allowed to lie until the following September or October, our spring, when it is eaten bare by cattle, and is then ready to produce hay or pasture, as may be desired. This is the means of increasing five, ten, and even fifteen fold the carrying capacity of thinly grassed rough lands, giving a profit during the transformation."

This is a more elaborate system than that in general use, however.

UNIVERSITY OF CALIFORNIA

about 300 miles south of the city of Buenos Aires, where he carries on mixed farming, wrote in May, 1903:

Last year I harvested 30 bushels of wheat per acre on a piece where this year I have very good alfalfa, while the alfalfa which I sowed with the wheat last year looks extremely well to-day. The advantages of sowing with wheat are obvious in the saving of another plowing and, far more than this, in the saving of time and having the alfalfa for the winter after the wheat is cut, which is the time when feed is most wanted. Until I see far more decided advantages than I do at present in sowing alone, I intend to continue sowing with wheat, so long as the latter remains a paying crop. As far as my experience goes there is no objection to grazing alfalfa with cattle while it is young. To do so with sheep and eat it bare would, I think, be dangerous, as they crop it too closely.

Mr. John Benitz says, concerning southern Cordoba, where he is now working about 60,000 acres, mostly in alfalfa:

I have had the best results by breaking up virgin camp in the fall or spring and at once cross disking, harrowing, and sowing with alfalfa alone and covering it with a lighter harrow. Alfalfa so sown can be stocked with cattle two or three months after sowing, fed down close and trampled. Then the stock should be taken off for a few months, and the alfalfa will grow splendidly. The ground being new, no grass or weeds come up. If alfalfa and wheat are sown together cattle can not be put on till a year after, but if sown alone cattle can be put on permanently when it is six months old.

In the north of Santa Fe, in the Jewish colony at Mosesville, the manager told me that it was not advisable to sow alfalfa there on new soil, and that a previous culture with corn, flax, or wheat was to be preferred.

GRAZING ALFALFA WHEN YOUNG.

The opinion seems to be quite general in Argentina that more or less feeding is good for alfalfa when it is young, certainly by the time it is five or six months old, as the tramping is beneficial and the plants should not be allowed to go to seed the first year. Sometimes sheep are put into the alfalfa pastures with an attendant to keep them moving and prevent them from eating too closely. They eat the weeds and do a fine job of tramping. Mr. Williams says that during a good spring it is impossible to keep the alfalfa down with grazing because the appliances for watering stock are not calculated for the number it would then carry. On a piece sown with wheat which gave 30 bushels to the acre last year he had for some time last spring, or less than a year after the wheat was cut, four to five animals, yearling calves and old cows, per hectare (2.471 acres), and he was at the same time cutting some of it for hay. In May, 1903, he had rather more than one cow per hectare fattening. Later on, if the weather got very dry and cold, he might not be able to keep any stock on it for a time. Some stockmen cut the alfalfa the first year and do not allow stock on it until it is about a year old. The difference of opinion on this point is due to different conditions and to overstocking young alfalfa. It requires experience to know how far to go with the feeding.

AMOUNT AND PRICE OF SEED.

The amount of seed sown varies greatly according to locality, individual opinion, and whether land is old or new. The amount per acre ranges from 9 to 35 pounds, generally from 11 to 18 pounds. More seed is used on old land than on new, though 18 pounds per acre is sown in southern Cordoba on new land without a nurse crop. The price of seed varies considerably, according to the season, for now it is all produced in the country. Seed is harvested in southern Cordoba, Santa Fe, and western Buenos Aires, while very pure seed is raised in Chubut in small quantities. A yellow butterfly or rain at the time of fertilization sometimes destroys the crop of seed. A dry season, checking the growth, is favorable to the production of seed, but it is not considered advisable to allow alfalfa to go to seed more than once in five years. Some ranchmen believe in letting it go to seed and resow itself. Seed is sold by the 10 kilos (22.046 pounds), and the price is from $1.42 to $2.84 United States money for that amount, or $3.35 to $7.70 per bushel of 60 pounds.

LIFE OF ARGENTINE ALFALFA.

More variation is found in the number of years alfalfa will live in Argentina than in any other feature of the business of growing it. Bad seasons and close feeding may wear it out in three years in some localities, while in other places fields that are cut only will live for twenty-five years and still make a good showing. The latter is a very rare and extreme case, and the former is quite unusual, except where the pasture has been abused. Alfalfa lives longest and gives best results in the light soil of the upper provinces, in western Buenos Aires and in San Luis. The strong native grasses, which after a few years overcome alfalfa in the Province of Buenos Aires, do not exist to the same extent in Cordoba, Santa Fe, and San Luis. The soil is not rich enough to sustain them, as they do not reach down for the moisture, so there is little to interfere with alfalfa in these regions. In Buenos Aires, from the city south, estancieros estimate that alfalfa, used only for cutting, and well cared for, will live from five to ten years, differing according to locality and seasons. One, who lives near the city and has a very large breeding establishment, manures his alfalfares, and they last seven or eight years, but he does not put cattle on them. If constantly fed, the life of the pastures in this province, except in the west, is not more than three or four years. The native grasses come up and choke it out.

In southern Cordoba alfalfa with ordinary care will last fifteen years, but if fed short it may be completely killed out in five years. It is said that cutting instead of grazing improves it by allowing it to come up to its full height, which is life to alfalfa. In the Province of Santa Fe estimates of the life of alfalfa range from three to twenty-five years, depending upon the seasons and how it is treated. When

cut often and not stocked with sheep and little or not at all with cattle, the estimates of its life are from ten to twenty-five years, with the majority around fifteen years.

In the Jewish colony in upper Santa Fe they say ten to fifteen years if cut only, or six years if fed. Indeed, Don Arturo Bab, the manager of the colony, says that there does not seem to be any limit there to the life of alfalfa that has been continually cut and fertilized by turning on cattle only in winter. He points to fields in that neighborhood fifteen years old and still in good condition. But if continually pastured, alfalfa in this region lasts but a few years, being crowded out by native grasses. These native grasses, says Señor Bab, will not sustain finely bred cattle, which deteriorate very rapidly and even die if given nothing else. Only native cattle can live on them, and even these will not fatten. The great heat in summer burns up the fine grasses; only alfalfa endures. The colonists under Señor Bab have found a sure and profitable business pasturing well-bred cattle on alfalfa. The carrying capacity there is estimated by the manager to average three-fourths of an animal per hectare (2.471 acres) on natural pastures, and on alfalfa five breeding animals or three for fattening. Of course this estimate is subject to great changes, according to the amount of rainfall.

Around Carcaraña, 30 miles west of Rosario, they have fields twenty-five years old, but the average is ten to fifteen years if cut, five to seven years if fed, and eight to nine years if fed and cut. This is about the average for the greater part of the alfalfa region, but of course varying conditions shorten or add to the life of alfalfa in different regions.

Little is done to prolong the life of alfalfa. Some farmers and ranchmen use disk harrows or plows in the spring with beneficial results. Some are of the opinion that this is of but little and only temporary benefit, and that it hardly pays. They say it is better and cheaper to let the alfalfa go to seed, resow itself, and then plow it. Others say that if they could get satisfactory disk harrows to cut 2 or 3 inches deep and not clog, such implements would be used with great benefit to alfalfa, starting new plants every spring, and would be generally used.

CATTLE-CARRYING CAPACITY OF ALFALFA.

Alfalfa never does less than to double the carrying capacity of the native grasses of Argentina, however rich they may be, unless it happens to be in a locality where rock is too near the surface for alfalfa to do well. Generally it multiplies the carrying capacity three to six times. In southern Cordoba, Santa Fe, western Buenos Aires, San Luis, and other favored alfalfa regions, 3,000 cattle are now being fattened all the year around on every league (6,672 acres) of alfalfa, and another thousand, or even more, might be added if they were all

breeding cattle. Hitherto these camps would carry only about 800 animals per league, and give the animals barely enough vitality in the summer to carry them through the winter. The native grass there is called "pasto fuerte," which means tough grass; and so it is, wiry and thin. Cattle rarely get fat on it, and only the tough, undersized native cattle can live on it. Better bred stock deteriorate at once; so this region and thousands of leagues of Argentine territory would not be stocked with good cattle without alfalfa. In south central Buenos Aires, where the native grasses have nearly all been killed off by overstocking with sheep, the hard, worthless "pasto puña" has come on and the fine grasses have no chance. The carrying capacity of this land was 2,500 to 3,000 sheep per league, or 500 cattle, and they barely managed to keep alive. Now, under alfalfa, the same land carries 7,000 sheep or 1,200 cattle and keeps them in good condition the year around.

At the rate of one animal to 8½ acres, the usual average carrying capacity of native grasses, alfalfa makes land for grazing purposes worth five to eight times as much as it was before alfalfa took the place of the native grasses. Some native pasture (Pl. III) in the Province of Buenos Aires will carry one animal for every 2 acres, but of course nothing will stand dry seasons as alfalfa does. This was thoroughly proved in the dry, cold winter of 1902 in Argentina. Alfalfa pastures that seemed to be all dead made an astonishing recovery the following spring. Ordinarily when the native grasses have been entirely dried up alfalfa is still green and furnishing food for the animals, because of its deep-drawn water supply. Indeed, it is quite safe to say that alfalfa pasture is always worth two to two and a half times as much as the best combination of native summer and winter grasses. It is often said that a native grass called "gramilla," which comes with alfalfa, adds to its feeding value.

The carrying capacity of alfalfa pasture in Argentina is estimated at from two and a half to four animals per square (4.17 acres) the year around, or, in round numbers, from three-fifths to one animal per acre. An animal here always means a beef animal, and it is estimated that any pasture will usually carry four times as many sheep as it will cattle. This estimate is for breeding cattle. For fattening it must be reduced somewhat, but not much. Except in the winter alfalfa pasture will fatten three to five rough animals per square in five to eight months. Rough thin work oxen are fattened in this time. There is a large business in raising feeders on poorer lands north or south on native grasses and driving them in great troops to the alfalfa fields to be fattened. As the animals approach within a few months of the age at which they should start for market they are shifted about from one pasture to another and are given the best on the place. At other times they are not moved much, but are left in one large pasture sufficient for their needs for a year.

WASTE OF ALFALFA AND OVERSTOCKING.

In the summer much alfalfa is allowed to go to waste because it is not always practicable to put more cattle on to fatten in the summer than can be carried through the winter. Some cutting of pastured alfalfa is often done. After the first spring growth has been eaten down the cattle are taken out for a few weeks and hay is put up, with a temporary fence built around the stacks. If the pasture gets poor in the winter, the fence is taken down and the cattle allowed to eat the hay in the stack. If not used during the winter, it may be sold in the spring. But this plan is not followed by all ranchmen. The ranchman (estanciero) is not always prepared to do much haying. He leaves that to the small farmer.

Overstocking is one of the weaknesses of the Argentine ranchman, though he is learning better through expensive lessons. When cattle were cheap and slaughtered for their hides it did not matter so much if a man lost a few thousand occasionally. He stocked his camp to the limit of its capacity at its best, and when a bad season came he lost half his stock or more. It often cost more to feed them than they were worth. Now, with valuable graded cattle they can not afford this. They have found by experience that alfalfa will be better in the winter and will live longer if it is not eaten down closely in the summer, but is permitted to grow to its full height.

MAKING HAY OF ALFALFA.

Raising alfalfa for hay is a good business in Argentina, if the haul to the railway station is not too long. It is done mostly by small farmers, "chacareros," within 10 or 15 miles of railway stations, though occasionally large estancias do a big business in it when favorably located. On these great ranches, however, alfalfa is used chiefly for grazing, and only enough is cut for hay to supply home needs and guard against a dry, cold winter, when the pastures run down. Valuable breeding stock is fed dry alfalfa more or less the year round, though there is a growing demand for a good quality of bulls, "á corral"—that is, bred to the open field and able to run with the herd and take chances the year round.

ADVANTAGES OF CUTTING AND GRAZING COMBINED.

There is little difference of opinion in Argentina about the advisability of cutting the surplus from alfalfa pastures in the summer. Unless double the number of animals are put on in the summer they can not eat the luxuriant crop that grows, and they waste it. "Theoretically," says Mr. Williams, in the south central part of the Province of Buenos Aires, "there is no reason why all the alfalfa should not be cut every year, but practically it is impossible to do so when dealing with thousands of hectares. It is much more economical to store it

for winter use by stacking than to allow it to grow into a tangled mass, which the cattle trample and spoil." Mr. John Benitz, of southern Cordoba, says: "Cutting improves alfalfa, allowing it to come up to its full height, which is life to it." He warns against the practice of stocking alfalfa to the limit in the summer time, saying: "Of course in the summer a great deal of the alfalfa goes to waste; but there is less risk of running short of feed in the winter, and it is this letting the alfalfa grow up to its full growth each summer that insures to it a great number of years of life."

Both these gentlemen have been very successful in their respective localities. Yet this system of grazing and one cutting is comparatively little followed in Argentina. Alfalfares are usually used altogether for hay or altogether for grazing. Only occasionally do ranchmen put up hay in the pasture with a fence around it, to be taken down in the winter to allow cattle to eat when they need it.

YIELD AND PROFITS OF ALFALFA AS HAY.

The yield per acre varies greatly in different seasons and localities. In central, eastern, and southern Buenos Aires three or four cuttings per year are considered good, and it is the exception to get five cuttings. The amount secured varies from 1,500 to 3,000 pounds per acre, generally about a ton per cutting the country over.

In southern Cordoba, in a great part of the Province of Santa Fe, and in western Buenos Aires alfalfa grows more rapidly and the yield per acre is much greater. Four to eight cuttings are secured every summer, and five to six cuttings is the average in good seasons in the best regions. Four cuttings is the general average to be relied upon. If rainfall is abundant, more will be secured. If the summer is dry, there may be only three cuttings.

An estimate[a] of the cost of making alfalfa hay and its value in the Jewish colony at Mosesville, about 100 miles northwest of the city of Santa Fe, is given herewith, converted into United States terms and with values expressed in United States currency:

Price in stack, per ton		$2.40
Cost of cutting, per acre, with machine	$0.36	
Raking, gathering, and stacking, per acre	.71	
Cost per ton, at 1 ton per acre		1.07
Net profit, per ton		1.33

Alfalfa in this region, for cutting exclusively, gives from five to eight cuttings per year. The average annual yield is better than 6½ tons per acre, so the farmer gets, in round numbers, from $6 to $10 per acre per year, or an average of $8.65 for the use of his land, horses, and machinery, all other expenses of the harvest being paid out of

[a] From the monthly "Anales" of the Argentine Rural Society for January, 1903. It corresponds very closely to an estimate made later by the manager of the colony.

FIG. 1.—TWO-YEAR OLD SHORTHORN HEIFERS IN ALFALFA, NORTHERN PART OF PROVINCE OF BUENOS AIRES.

FIG. 2.—STACK OF ALFALFA CONTAINING 100 TONS, 60 MILES FROM BUENOS AIRES. IN FRONT IS "TROJA," OR ARGENTINE CORN CRIB.

the cost estimate of $1.07 per acre, or per ton. Stock is never put on during the first year of growth there. They sow 23 to 27 pounds of seed per acre.

The cost of preparing for market or for export is given by the same authorities as follows:

	Cost per ton.
Baling with machine	$1.60
Wire	.30
Hauling, 9 to 13 miles to station	.72
Loading cars	.22
Commission and various charges	.44
Add price in stack	2.40
Cost baled	5.68
Freight to Santa Fe or Colastine, nearest river ports	1.75
Cost at the Parana River	7.43

Prices in the Santa Fe and other upper-river markets at this time were about $9.50 per ton, leaving a handsome profit to the buyers. The freight to Buenos Aires from the station nearest the colony, to which the haul would not be over 5 or 6 miles, is a little over $4 per ton, and the distance is about 355 miles.

Much complaint is made of the high freight rates, which greatly retard the development of the hay industry. Prices in the Buenos Aires market were at this time and are now (December, 1903) about $12 to $13 a ton for the best alfalfa hay. During the winter of 1903, in the month of August, it was quoted there at from $15 to $19.25 per ton. The producers who had not previously sold their hay in the stack received much more than $2.40 a ton for it then. Prices are better toward spring, and are higher nearer the city of Buenos Aires. Jewish colonists are going more into alfalfa, corn, and stock raising, growing less wheat, which has proved a failure in this region in recent years. The Italian and other farmers in that part of the country have done likewise and profited well by it. Farmers who have stuck to wheat have brought poverty upon themselves, while those who have done mixed farming, with alfalfa and corn and stock to eat it, exhibit every indication of prosperity.

LOSSES IN THE STACK.

Losses are sustained everywhere in the alfalfa hay business by the failure of the stacks to shed water. These losses are estimated at from 8 to 30 per cent of the total amount, depending upon how well the stack was made, how large it was, and how much rain fell. Sometimes in wet weather the outside of stacks to the depth of a yard must be thrown away when it is baled. This leads to large stacks, such as the one shown in the illustration (Pl. IV, fig. 2), which contains 100 tons and is well proportioned. Losses are also often suffered by rains coming on when the alfalfa is in the cock and ruining it altogether if the rain lasts any lenth of time.

MARKETING AND MARKETS.

Bales for export weigh 50 kilograms, or 110 pounds, and are made in United States steam presses. Very large bales, weighing several hundred pounds, are made in hand presses for domestic use.

Alfalfa hay is an important article of export from Argentina, and the increase of this trade is predicted by Argentine authorities. It originated in 1864, when, during the war with Paraguay, Argentina was obliged to send alfalfa for the horses of the allies, Brazil, Uruguay, and Argentina. This led to a trade in alfalfa hay with Brazil, though it did not amount to much until about 1890, in which year about 22,000 tons were exported. The amounts exported annually since, with the average values of the export product, were as follows:[a]

Exports of alfalfa from Argentina.

Year.	Tons.	Price per ton.	Year.	Tons.	Price per ton.	Year.	Tons.	Price per ton.
1891	33,073	$12.25	1895	79,320	$5.26	1899	116,401	$9.61
1892	43,220	8.36	1896	115,471	7.52	1900	113,356	10.91
1893	58,998	10.44	1897	114,308	7.88	1901	104,851	8.65
1894	52,489	8.39	1898	125,148	9.61	1902	108,208	8.86

These prices are about the average market prices for the years quoted in the Buenos Aires market. It is said that the reduction in the amount exported during 1901 and 1902 was due to the fact that the English ports were closed to Argentine live stock during those years on account of foot-and-mouth disease in Argentina. This operated, for various reasons, to interfere with the exportation of alfalfa to that market. The principal markets for hay from Argentina are Brazil, England, and South Africa.

FEEDING ALFALFA HAY AND CORN.

Progressive cattlemen, almost without exception, as far as seen by the writer, are looking forward to the time when they must feed their steers with alfalfa hay and Indian corn to get the best results. The recent outbreak of foot-and-mouth disease in the country will check this movement somewhat, because it is likely to delay the reopening of the English ports to Argentine live stock. The animal sanitary law in Argentina is very thorough, and every effort is made to enforce it, to prevent the spread of the disease, and to exterminate it; but after the outbreak of 1900 seemed to have entirely disappeared it was about two years before the British Board of Agriculture would reopen the ports to Argentine live cattle and sheep. They remained closed from April, 1900, to February 3, 1903, and were again closed in May, 1903. It was thought that this would be only temporary, but the disease got out into the country and even made its appearance in

[a] Argentine custom-house statistics, reduced to avoirdupois tons, and prices per avoirdupois ton in United States currency.

the great annual expositions of breeding stock in Rosario and Buenos Aires in September and October, 1903. The disease, while quite general in extent, was mild in character and disappeared in a few months.

Advanced stockmen are very generally agreed now that it will pay them to finish their export animals on dry alfalfa and corn and to give them dry alfalfa in the winter time if the pastures run low. The great majority agree, except as to how long they should feed the animals before shipping. Opinions on this point vary from two to six months. They all know that cattle fed only on grass or alfalfa lose on a railway journey, and lose still more from the time they arrive at the port of export if they are to be exported alive. They are more or less wild, and they do not know how to eat the hay and corn which is given to them in the export yard and on board ship. Consequently heavy losses are suffered by the exporters, who become very cautious and cut down on the price of steers not trained to eat corn. This feeding has been done on a small scale already with very profitable results, but the high price of corn has discouraged it. Corn has been worth from 30 to 35 cents per bushel on the farm the past two years, and has sometimes been worth even more. Some of the more progressive ranchmen are planning to raise their own corn for feeding and do it in a more intelligent manner and get better results than the average small farmer.

SUPERIORITY OF CORN-FED BEEF.

The proposition to feed dry alfalfa and corn has applied only to steers for export alive, but it is bound to be applied also to those destined for chilled beef, for experience is gradually teaching Argentine beef producers that a grass or alfalfa fed steer can not compete with a corn-fed steer. The latter will be sounder, more solid, and his carcass will cut up to much better advantage. The corn-fed beef is worth more to the pound, because it is firmer and has less water in it than that of animals fattened on green alfalfa or grass only. The increase in the number of chilled and frozen meat companies in Argentina is stimulating a demand among the first-named concerns for superior steers, and better prices are being paid. It is certain that they will pay more for corn-fed animals than for the soft alfalfa beeves. Whether or not they will pay enough more to warrant the expense of several months' feeding is not yet proved. But as soon as the English ports are open to Argentine live stock, feeding corn and dry alfalfa will be a general rule.

GROWTH AND PROFITS OF CHILLED-BEEF TRADE.

The business of producing fat steers in Argentina has been subject to more fluctuations than in the United States, but is now approaching steadier conditions. Alfalfa has been the chief factor in removing the element of chance from the industry. Its intelligent use has taken

away every risk from starvation in dry, cold winters. It has increased the production of good cattle and made the future supply certain; so that more chilled-meat concerns are entering the field, making a better market. The chilled and frozen meat companies now operating in Argentina are as follows, with their daily capacity:

Frozen-meat companies in Argentina.

Name.	Location.	Daily capacity.	
		Steers.	Sheep.
Sansinena	Buenos Aires	250	6,000
Las Palmas	Zarate	170	3,000
Drabble Bros	Campana	170	3,000
La Blanca	Buenos Aires	150	3,000
Cold Storage Co	La Plata	300	6,000
Sansinena	Bahia Blanca	150	3,000

One or two large chilled or frozen meat establishments will be completed soon in Rosario and one or two more in Buenos Aires. La Blanca and Sansinena at Bahia Blanca, listed above, are new. An American company has been organized to build one in Necochea, south of Buenos Aires, and it is understood this company will ship chilled meat to New York. Several other companies are being organized, as the older companies, the first three named, have been earning large dividends—from 20 to 40 per cent—while they controlled the market.

PRICES OF CATTLE AND SHEEP.

The competition of the chilled-beef companies and the shortage of the supply in the winter and spring of 1903 (the months from June to November) stimulated the price of both cattle and sheep in Buenos Aires. When the English ports were closed, in May, 1903, good export steers—and the best were demanded for this trade—were selling at from $40 to $50 each. As soon as the ports were closed prices fell nearly 20 per cent on cattle, but not on sheep. In four months these prices were nearly restored, while prices for sheep had been going up for eighteen months, and fat wethers were selling at $5 to $6.50 down to $2.50 for common grades and $1.30 to $2.65 for lambs.[a]

LATER CONDITIONS NOT SO FAVORABLE.

A decline in the price of sheep began in November, 1903, and continued until January, when the price began to recover slightly. The decline was about 33 per cent at its greatest, and in March, 1904, prices for the best types of mutton and lambs were still 20 to 25 per cent lower than they were in July or August, 1903; but were rising.

In December, 1903, the frigorificos suddenly reduced their operations. Some of them practically closed down for the time. The reason assigned was that the demand for Argentine chilled and frozen meat had fallen off in England, and that the prices of steers had

[a] In 1902 the average price of native sheep of 60 to 100 pounds weight in the Chicago market was $1.25 to $6.50, and for native yearlings and lambs $2 to $7.25.

advanced in Argentina until it was no longer profitable. The companies were making no profits. There had been a heavy decline in the market price of shares in the Argentine freezing companies. The result of this action was an immediate drop of from 15 to 25 per cent in the price of steers. There has been but little recovery in this price up to the 1st of March, 1904. When the cooler weather begins work in the freezing plants is resumed and prices of steers and sheep improve. A large number of fat young steers are ready to be placed upon the market there. Exporters, stockmen, and Government officials are endeavoring to find an outlet for this production. A shipment of Argentine chilled meat was rejected in Austria on some hygienic ground, but it is claimed by the Argentines that it was done because of the opposition of the agrarian interests. Argentines have been shipping some chilled meat and some live animals to other European ports during the past year, including Hamburg, Lisbon, and some of the Spanish ports. They are striving hard to develop a market on the continent of Europe for their various meat products, and are meeting with some success.

Steers come to market now usually about three years old, and this is a gain over former years, due to alfalfa. Formerly weight counted more than quality, and steers were kept on grass till they were four or five years old. Now the lighter, young beef is preferred, as in this country. The favorite weights are 1,200 to 1,400 pounds.

Feeders, about two years old or a little more and very thin, are bought for $9 or $10 per head, put on alfalfa pasture for six to ten months, and sold for $30 to $40. A good business is done by a few estancieros in buying up old work oxen in exceedingly poor condition, paying $13 to $15.50 for them, putting them on alfalfa for six to eight months, and selling them for from $24 to $30. Fairly good grade steers, three years old, fattened on alfalfa pastures, are now selling for $40 to $48 in the country stations in Argentina, and it costs $4 or $5 per head to get them to the slaughtering places in the ports. This does not include the taxes on sales that are levied in some of the provinces nor the taxes levied by the municipalities where the slaughtering is done. These taxes vary, but will amount to several dollars more. Nearly all of this type go to the "frigorificos," or chilled and frozen meat institutions, for export.

UNITED STATES BEEF TRADE AS COMPARED WITH ARGENTINE.

Very briefly stated, for comparison, the business of exporting steers from the United States is carried on about as follows: Good grade steers are procured, either from farther west or at home, and are fed mostly in the central corn States for Chicago, where most of them are shipped. Feeding to fatten usually begins at the age of from sixteen to twenty months and lasts from three to six months. Then they are shipped to Chicago to be sold. Freight rates range from 18½ to 35½ cents per 100 pounds in carload lots from the feeding places to Chi-

cago. From Nebraska points the rate is 30½ to 35½ cents; from Missouri and Iowa points the rates are usually about 22 to 23½ cents, though a few points have as low a rate as 18½ to 19 cents; Kansas rates are 32½ to 37½ cents, with but few shipments to Chicago; rates in the State of Illinois vary greatly, but are much lower than Iowa or Missouri rates. In the Chicago Stock Yards these animals pay 50 cents each commission charge and 25 cents each yardage. They must also pay for feed, but if they are shipped east for export on the day of arrival this is very small. In the Chicago yards steers are sorted for local slaughter, export, or eastern markets. Comparatively light young steers, weighing from 1,175 to 1,300 pounds, are wanted for export, and these sell from $4.40 to $6 per 100 pounds, live weight, though of course these prices vary widely at different times. The best steers, the special young "baby beeves," that bring the highest prices, are not exported, but are reserved for fancy beef in the large city markets. The export steers are, however, of a superior quality. Prices in December, 1903, in the Chicago market were: Low-grade export steers, $4.40 to $4.70; good export steers, $4.70 to $5.15, and for prime fat beeves of 1,175 to 1,300 pounds weight, $5.15 to $5.50. The freight from Chicago to New York is 28 cents per 100 pounds, live weight. If loading on shipboard is prompt, charges in New York are light, not more than in Chicago. The ocean freight rates to English ports are from 30 to 35 shillings ($7.30 to $8.50) per head. Insurance is one-half of 1 per cent, and steers are insured for $50 per head, except "distillers"—those fed on distillery waste—which are valued at $75 each.

No charge is made for the inspection by the United States Bureau of Animal Industry at the Chicago Stock Yards and at the port of export. Every animal is tagged and numbered, so his identity is never lost, and the record is so complete that if it becomes necessary the animal can be traced from the English slaughterhouse back to the farm on which he was raised or fattened. This record is sent to the Bureau of Animal Industry inspector in the foreign cattle market at Deptford, near London, whose business it is to watch the results of the slaughter of steers from the United States and report by cable the tag number of any animal showing any disease that requires investigation. The matter is promptly followed up from this end, so that quarantine or other precautionary measures may be taken if necessary. These precautions are taken by the United States Government for the protection of the cattle trade, to make certain that every animal, as well as the chilled beef exported, is in perfect condition and the accommodations on shipboard are of the most approved kind.[a]

[a] The Argentine Bureau of Animal Industry inspects all cattle that are to be exported, first on the ranch before they are shipped and afterwards at the port of export. Inspectors are also stationed in all the chilled and frozen meat establishments and in the city slaughterhouses, to see that no diseased animals are used for food.

FINE CATTLE OF ARGENTINA IN SHOW AND AUCTION.

FAT STOCK SHOW OF 1903.

In May the Argentine Rural Society gives a fat stock and horse show, to which, for the first time, in 1903, was added an exposition of agricultural products. There is generally a lively competition for the championship in the fat steer class, though there is no such scientific feeding competition, exemplified in a single animal, as we have every year in the International Live-Stock Exposition in Chicago. The entries are made in lots of 8 animals, and while they are fed for exhibition, they are prepared under conditions approaching the normal, or what the average, progressive ranchman might do if he chose. These expositions have a positive influence upon beef production in the country, showing what may be done by breeding and feeding.

PRIZE WINNERS.

One man exhibited 9 lots of 8 animals each in the last show, and took first, second, and third prizes in a competition of 26 lots. All the prize winners were pure white well-bred Shorthorns, and so were most of the 72 animals shown by this breeder, Dr. Benito Villanueva, who is the presiding officer of the lower house of the Argentine Congress. The prize lot averaged 2,145 pounds each when they were weighed on the show grounds, and the exhibitor claims they had lost about 60 pounds each after they left his estancia, distant about 194 miles by rail. Of course these animals were tame, having been much handled and sheltered, so they lost less in transit than the average Argentine steer. These were born in January and February, 1898. This class was for steers of three, four, and five years, and most of them were from four to five. All of Doctor Villanueva's steers were dehorned, a practice in which he thoroughly believes, though it is not generally practiced in Argentina. Doctor Villanueva's manager, who prepared these animals for the show, told me that he took them off alfalfa pasture and fed them on corn and dry alfalfa and gave them shelter when necessary for ten months before the show. Part of the time they had the run of the alfalfa pasture also. These animals made a beautiful showing in the parade and overcame the prejudice of many breeders against white coats. This objection has been and is yet very strong among Argentine breeders. An incident in the pedigreed-stock show of last October confirmed it. A white bull won one of the principal first prizes, but in the sale that followed he sold for less than one-third the price of several others of his class, less than half the price of many, and was sold, in fact, for a very low price, though the only objection to him was his color.

The prize lot of fat steers was presented by its owner to the Chilean delegation, at that time on its official peace jubilee visit to Buenos Aires, and the animals were slaughtered, and the beef used on board the Chilean naval vessels then in the Buenos Aires docks.

AUCTION SALES.

The sales at auction of fat steers, held on the grounds, were very unsatisfactory to the exhibitors. Exportation on the hoof had been stopped by an outbreak of foot-and-mouth disease a few days before, and the "frigorificos" (frozen and chilled meat companies) evidently had an understanding among themselves not to pay the high prices which they had paid the year before. As these companies offer the only market for good steers, they have the producers at their mercy when they can agree. A few representative sales are given herewith, showing weights per animal in pounds, with prices per animal in United States currency:

Shorthorns.				*Polled Angus.*		*Flemish.*	
Weight.	Price.	Weight.	Price.	Weight.	Price.	Weight.	Price.
1,648	$53	1,607	$57	1,261	$37	1,431	$40
1,865	75	1,561	48	1,380	48	1,402	40
2,070	75	1,925	75	1,501	48	1,312	37
1,874	57			1,435	44		

FAT STEERS FOR SALE ONLY.

In this class 31 lots of 8 animals each were shown, all but one being Shorthorns and Shorthorn grades. This one group, weight 1,407 pounds each, was a Shorthorn-Polled Angus cross. Some of the weights and sales follow:

Shorthorns and Angus grades.

Weight.	Price.	Weight.	Price.	Weight.	Price.
1,285	$37	1,753	$53	1,407	$48
1,349	37	1,570	48	1,543	53
1,519	40	1,594	48	1,587	53
1,949	53	1,495	48		

FAT COWS AND STEERS.

Twelve lots of fat cows were entered for prizes in a class admitting any age or breed. Two of the sales (Shorthorns) were: Weight, 1,521 pounds; price, $37. Weight, 1,517 pounds; price, $37.

The Polled Angus steers, of which six lots, 48 animals, were shown, made a very good impression. They were three and four years old, and, though lighter than the prize-competing Shorthorns, brought better prices in proportion to their weight, as the lighter-weight grade Shorthorns did also. Three lots, representing a cross of Flemish and Shorthorn, made fairly acceptable weights, but brought moderate prices. The Herefords, which up to 1901 had taken the championship in the fat-steer class, were not represented in any way. The Hereford does not seem to be gaining ground in Argentina, as the Polled Durham notably is and the Polled Angus to some extent.

SHEEP, HORSES, AND POULTRY.

The showing of sheep (Pl. V) was small. Two groups of Lincolns and three of "Black Faces" (Hampshire Downs), each of 40 animals, completed the sheep exhibit. The prize Lincolns, averaging 176

FIG. 1.—SHEEP IN THE PARK OF THE ESTANCIA SAN JUAN, PROPERTY OF DON LEONARDO PEREYRA, NEAR BUENOS AIRES.

UNIVERSITY OF THE

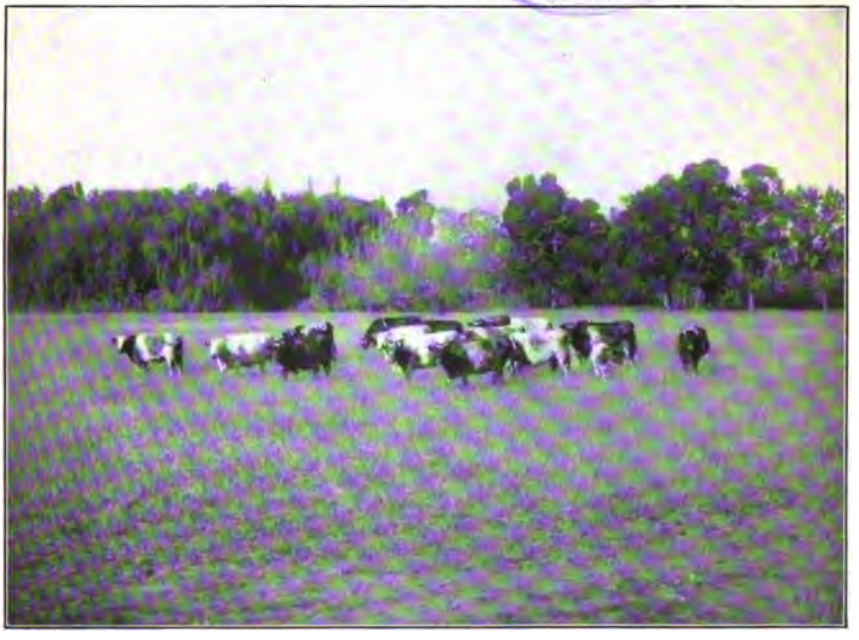

FIG. 2.—PURE BRED DURHAM COWS ON PEREYRA ESTANCIA, NEAR BUENOS AIRES.

pounds, sold for an average of $4.84 each. The "Black Faces," though much lighter in weight, sold for about the same.

The horse show, though not large, brought out some very good roadsters and saddle horses. The prices realized in the sales were not high, but a little above those in the show of the previous September.

Interest in poultry was shown by good exhibits of Dorkings, Plymouth Rocks, Light Brahmas, etc. A few ducks and turkeys were exhibited.

Not a pig was to be seen in the show.

HIGH PRICES FOR BREEDING ANIMALS.

The demand for the best Shorthorn blood is increasing in Argentina, and it is a better market for good young bulls than ever before. Every ranchman is trying to improve the standard of his herd, culling out the undesirable cows, getting as good bulls as he can afford to buy, and preparing to give his cattle alfalfa pasture, if not to finish them with corn and dry alfalfa. The aim of everyone is to produce steers for export, either alive or as chilled beef. This has multiplied the requirements of the country for breeding stock. There is no indication of a decrease in the demand, but rather of an increase, for the planting of alfalfa is more than doubling the carrying capacity of Argentine grazing land, while the building of new "frigorificos" insures better prices because of competition.

Dr. E. Ramos Mexia, president of the Argentine National Rural Society, expressed the opinion, in his address upon the opening of the annual show in September, 1903, that exportation of cattle alive from Argentina was an unstable business that could never compete with the "frigorificos." "With one-fourth the cost of transportation," he said, "chilled meat brings the same price as that sent on the hoof." The losses suffered by those engaged in shipping live steers from Argentina to England from February to May, 1903, when English ports were open to Argentine live stock, and the high prices for both steers and sheep prevailing since the English ports were closed to Argentina, are facts cited by Dr. Ramos Mexia in support of his statement.

SALES OF SHORTHORN BULLS.

In an auction sale in Buenos Aires November 4, 1903, a Shorthorn bull from the herd of William Duthie, just imported, was sold to Don Gregorio Villafañe, who is the leading Hereford breeder of the country, for $7,260, the highest price ever paid for a bull in Argentina. Others in the same lot were sold for $3,960, $3,080, $1,760, and so on, the lowest being $880, and the average for the nine being $2,479. Several other sales of English, Scotch, and Irish bulls were held in Buenos Aires during September and October, when the prices were from $700 to $3,500, and probably about 150 imported animals were

sold at these prices. These sales have continued at short intervals since that time, and high prices have always been realized for Shorthorns imported from England.

PRICES AT NATIONAL LIVE-STOCK SHOW.

At the time of the National Live Stock Show in Buenos Aires in September and October, 1902,[a] the opinion was quite general that the prices then paid for breeding animals raised in the country would not be maintained another year. Both breeders and auctioneers said so. But, on the contrary, the sales at the recent show in September and October, 1903, brought better prices than in 1902, and under very discouraging circumstances. Foot-and-mouth disease had broken out in the show itself, as it was prevalent in the country. It is stated that 40 per cent of the animals on exhibition had the disease. Many animals were sold when they were actually afflicted, but it does not seem to have discouraged the payment of good prices. The disease is said to have been in a mild form, and but very few animals died. Those kept in pens in the open air were much less affected than those in stalls and, if they did take the disease, fell away much less than the carefully prepared show animals in the sheds. Animals brought up in the open field showed more vitality, and this is one reason for the high prices obtained for grade bulls bred in the open, without shelter. The average price paid for all Shorthorn bulls, pedigreed and grade, field bred and stable bred, in 1902 was $372. In 1903 the average price of 483 Shorthorn bulls of all grades sold by one auction house was $595. The total sales of breeding stock in this show were $668,404, of which this house sold $408,544, or more than 61 per cent, so the average of its sales is not far from the average for the entire show. The sales of 1903 exceeded those of 1902 by $100,013, or nearly 18 per cent, though the number of entries was smaller. Every animal shown or sold in this show was born in Argentina, for this was a national show, and no animals except those bred in the country could be shown or sold on the grounds. This year's show, in September and October, 1904, may be an international show, when imported animals may be entered for prizes and for sale.

BREEDING-STOCK SHOW.

ENTRIES OF CATTLE, HORSES, AND SHEEP.

The entries in the breeding-stock show of September and October, 1903, were as follows:

Shorthorns.

Registered bulls	243
Registered bulls for sale only	184
Grade bulls	1,017
Registered cows	61

[a] See "The animal industry of Argentina," by Frank W. Bicknell, Bulletin No. 48, Bureau of Animal Industry, U. S. Department of Agriculture.

Grade cows	360
Registered Polled Durham bulls	7
Registered Polled Durham cows	5
Total Shorthorns	1,877

Herefords.

Registered bulls	47
Registered bulls for sale only	27
Grade bulls	39
Registered cows	28
Grade cows	34
Total Herefords	175

Other breeds.

Registered Polled Angus bulls	3
Registered Holstein and Flemish bulls	25
Grade Polled Angus, Holstein and Flemish bulls	32
Total	60

Total cattle, 2,112.

Horses.

Stallions:	
Riding	12
Light driving	56
Heavy	54
Light and heavy road, for sale only	48
Camp mares	90
Total horses	260

Sheep.

Merino rams	335
Merino ewes	80
Lincoln rams	275
Lincoln ewes	100
Southdown and Shropshire Down rams	40
Southdown and Shropshire Down ewes	20
Oxfordshire Down rams	30
Oxfordshire Down ewes	20
Hampshire Down rams	40
Hampshire Down ewes	20
For sale only:	
Rambouillet rams	121
Rambouillet ewes	50
Lincoln rams	188
Lincoln ewes	12
Oxfordshire Down rams	10
Oxfordshire Down ewes	20
Hampshire Down rams	30
Total sheep	1,391

PRIZE WINNERS AND PRICES.

The sales of prize winners in the pedigreed Shorthorn classes were as follows:

Born March 1 to December 31, 1900.—First prize and championship to Ladas 6th, red and white, born September 27, 1900, sold for $4,840; second, a roan, sold last year for $4,400; third, a roan, sold for $2,508; fourth, a roan, sold for $2,508. In this class there were 41 entries and 25 sales, at an average of $1,466; the lowest was $396 and the highest $4,840.

Born January 1 to June 30, 1901.—First prize, red and white, sold for $1,848; second, roan, $1,364; third, roan, $1,320; fourth, red and white, $1,320. There were 45 entries, 34 sales, and the average was $1,195 each; the highest was $2,728 and the lowest $352. Eleven bulls of this class were sold for $1,140 or more each.

Born July 1 to December 31, 1901.—First, a white bull that sold for only $748; second, roan, $2,288; third, red and white, $2,640; fourth, red, $748. There were 91 entries and 57 sales, the average being $1,088; the highest was $4,840 and the lowest $396. Twelve were sold for prices above $1,540.

Born January 1 to June 30, 1902.—First, not sold; second, roan, $2,640; third, not for sale; fourth, red and white, $506. There were 20 entries and but 6 sales, as most of these young bulls are reserved for the next year's sales. The highest price paid was $2,640 and the lowest $418.

AUCTION SALES OF CATTLE, HORSES, SHEEP, AND HOGS.

Details covering about two-thirds of all the animals sold in the show indicate the general character of the whole, all sales being at auction. These sales, amounting to $408,544 in United States currency, were as follows:

Number and kind of animals sold.	Amount of sales.	Prices per animal.		
		Average.	Highest.	Lowest.
Pedigreed cattle:				
198 Shorthorn bulls	$186,175	$940	$4,840	$286
10 Hereford bulls	4,777	477	1,320	264
4 Flemish bulls	1,826	456	660	264
Grade cattle:				
285 Shorthorn bulls	101,409	356	1,650	53
16 Hereford bulls	1,760	110	137	53
93 cows and heifers	9,750	105	286	26
Pure bred horses:				
10 Clydesdale stallions	6,820	682	1,342	264
9 Hackney stallions	4,576	508	1,430	264
2 Anglo-Norman stallions	668	334	334	334
13 Percheron stallions	9,328	718	1,364	374
8 Shire stallions	4,288	536	748	308
9 Yorkshire stallions	3,190	354	484	220
2 Hackney ponies	228	114	114	114
6 Hackney mares	2,028	338	396	242
Grade mares:				
16 cart mares	1,120	70	.....	.....
8 coaching mares	440	55	.....	.....
36 Clydesdales	4,356	121	.....	.....
12 coaching mares	552	46	.....	.....
8 Hackney mares	352	44	.....	.....
6 female asses	158	26	.....	.....

Number and kind of animals sold.	Amount of sales.	Prices per animal.		
		Average.	Highest.	Lowest.
Sheep:				
217 Merino rams	$41,996	$194	$1,760	$15
25 Merino ewes	352	14	18	13
142 Lincoln rams	17,318	122	1,056	44
18 Hampshire rams	1,848	103	264	75
30 Hampshire ewes	858	29		
1 Shropshire ram	75			
5 Shropshire ewes	286	57		
15 Oxfordshire Down rams	1,553	104	154	4
Hogs:				
4 male and 4 female Yorkshires	680	85	101	79
3 Berkshire boars	123	41	44	40

A new ruling of the Rural Society requires the auctioneers to collect their commission of 6 per cent from the buyers, who pay cash, and the auctioneers must pay 2 per cent of their commissions to the society. Auctioneers' commissions are now always paid by purchasers.

Herefords and Polled Angus were rather poorly represented, and prices, it will be noticed, were far below those obtained for Shorthorns.

One breeder sold 26 young pedigreed Shorthorn bulls for an average of $1,310 each. Another sold 24 "camp" bulls, with which no special pains had been taken, for $924 each. Several other breeders did nearly as well with Shorthorns. The sales were all extremely satisfactory.

The development of the dairy interest continues, and the exhibits and attention paid to this department by the people excelled the previous year. The demand for dairy machinery and appliances is very active.

The popularity of the Merinos is also shown by the sales. The average price for Rambouillet rams in 1902 was $159, while this year (1903) it was $194. One ram sold for $1,760 and another for $1,408. The former is the highest price ever paid for a ram born in the country. The highest price the previous year was $880. The lot of 10 to which the two mentioned belonged averaged $422 each. The sire of these rams was imported from Germany in 1900 and sold for $2,464. In 1903 335 Rambouillet rams were shown, against 304 the previous year. In Lincolns 832 rams were shown in 1902, and only 463 in 1903. The average price in 1902 was $99, and in 1903 the average of one auctioneer was $122, the higher prices being no doubt due to the smaller number offered. The champion Lincoln ram in 1902 sold for $704, and in 1903 the champion brought $1,056 and another one $880. In January, 1904, a Lincoln ram lamb, bred in the country, sold for $4,600 paper ($2,024 United States money), the highest price ever paid for a native Lincoln ram in Argentina.

Horse sales were about the same as in 1902, but prices were slightly better for the best of the draft animals and for the light roadsters, but lower for the common "camp" mares.

A few pigs were offered, but most of the classes were without entries

IMPORTS OF BREEDING STOCK.

Imports of pedigreed stock into Argentina for breeding purposes have been as follows since 1896:

Annual imports of animals by classes.

Year.	Cattle.	Sheep.	Horses.	Asses.	Pigs.
1896	988	7,305	163	116	105
1897	916	7,309	184	71	25
1898	623	6,962	154	31	2
1899	1,561	4,839	129	7	19
1900	938	9,165	203	74	3
1901	26	154	441	15	.....
1902	64	272	30	.....	5
1903	653	1,877	51	22	19

The classification of the principal breeds was as follows:

Imports of cattle by breeds.

Breeds.	1899.	1900.	1901.	1902.	1903.
Durham	502	300	.....	32	572
Hereford	46	14	.....	6	31
Polled Angus	25	6	.....	4	38
Red Shorthorn	314	118	.....	7	.....

Imports of sheep by breeds.

Breeds.	1899.	1900.	1901.	1902.	1903.
Lincoln	3,597	1,869	.....	271	1,179
Rambouillet	485	269	61	.....	.....
Hampshiredown	381	64	.....	.....	253
Shropshire	284	123	.....	.....	299
Oxford	103	50	.....	.....	44
Romney	.....	38	.....	.....	71
Leicester	30	.....	.....	.....	25

These statistics were prepared by the Bureau of Statistics of the Argentine Department of Agriculture.

HANDLING CATTLE IN THE "BRÉTE."

While there are many wild cattle in Argentina that have never felt the civilizing influence of improved blood or modern treatment, these are not the ones with which the world's beef markets are concerned. The best steers are mostly unfamiliar with any feed but grass and alfalfa and are provided with no shelter, but they are more or less tame. They are not the wild, racing creatures we have read about

and seen pictured in the geographies. The well-managed estancia has its cattle well in hand, keeping close account of them and handling them frequently, so they become more or less tractable. They are often sorted and separated into different lots for feeding on different pastures for market at different times. Then there is the branding, the vaccination for anthrax, the castration, sometimes the trimming or removing of horns, and various other operations. All these things, if properly done, teach the animals not to fear being handled and make them better travelers when they go to market by rail or sea, or both. This training, when supplemented by a little feeding on dry alfalfa and corn, gives the steer raised by modern methods an immense advantage over the wild animals that find their way to Buenos Aires, especially if destined to go on board ship for transportation to markets over seas.

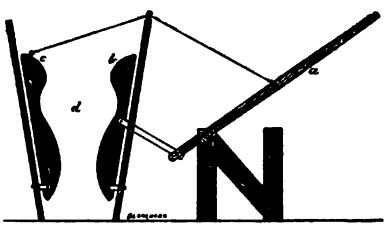

FIG. 1.—The yoke of the bréte. This yoke is placed inside the framework of the narrow chute, at the end nearest the scale. When the animal, released from behind, puts his head through the opening *d*, the man stationed at the lever, *a*, quickly pushes it down. This action closes the arms of the yoke, *c* and *b*, upon the animal's neck. The lever pushes the arm *b* and, by means of the wire running from the arm *c* over the top of the bréte to the lever *a*, pulls that arm, so they close quickly and simultaneously. After the desired operation is performed upon the animal, the lever is thrown up and he is released. The triangular swing gate is swung to permit the animal to pass to the scale or to the paddock, as desired. After he is weighed, the gate at the end of the scale may be adjusted to turn the animal either way, to the right or left, and in this way they are sorted. On the other side of the bréte, behind the yoke, is another lever, similar to the one shown above, by which the animal may be held more closely by having an adjustable board pressed firmly against him, forcing him against the operating side of the chute, where he is already held by his head, or neck.

The wild creatures wear themselves out trying to break away. They are in abject terror of everything near them, for they have never been restrained in any way before. Everything is new, and they do not understand that they will not be hurt, as the better trained animals do. They have never seen any dry food, and for days they do not eat. In the meantime the corral-broken animals are not losing, but are eating all they can get, including the portions of their frightened companions, and are gaining flesh from the moment they are unloaded from the trains that bring them to Buenos Aires. They are accustomed to being handled in close quarters from their calfhood, and they fear nothing.

The most necessary handling of the wilder steers was formerly done by means of a long rope lassoed around the animal's horns and passed around two upright revolving posts. The animal was then dragged to the posts by a horse and held there with much difficulty and more or less brutality while any necessary operation was performed. Naturally this does not tend to quiet the animal's fears or make him tame. It is

still done on some of the old native estancias, where modern methods have not been adopted, and the only question asked about a bull is whether or not he is capable of performing his function. But the

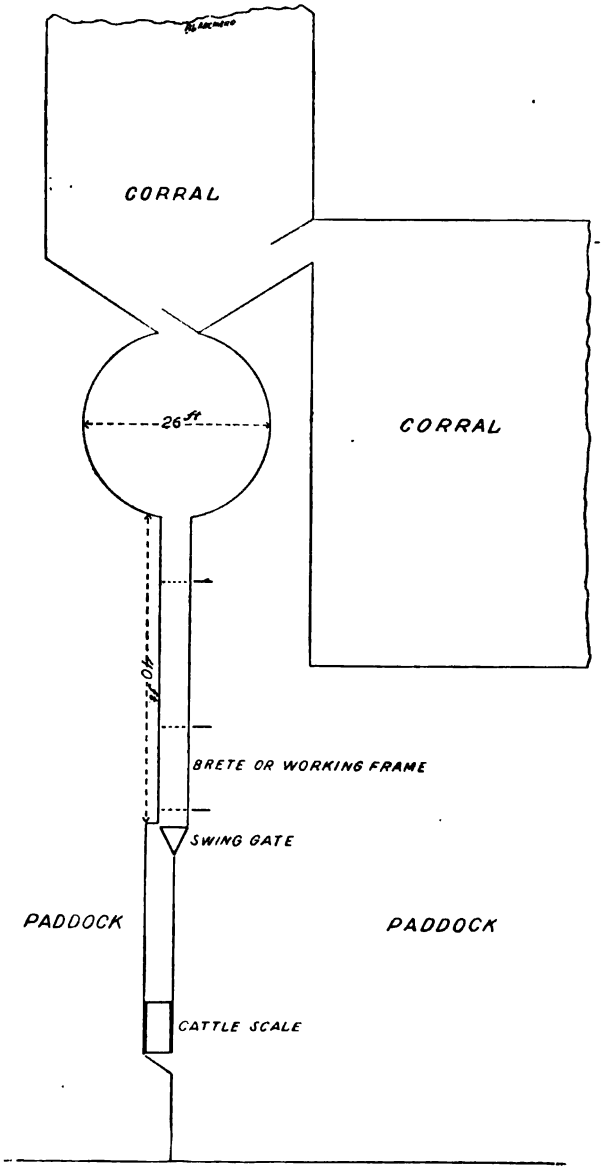

FIG. 2.—Ground plan of the bréte.

more progressive, and hence more successful, estancias have adopted an idea which came from Australia and has proved of great value where large numbers of cattle are to be handled frequently.

FIG. 1.—CORRALS LEADING INTO BRÉTE.

FIG. 2.—WORKING SIDE OF BRÉTE.

FIG. 3.—BACK SIDE OF BRÉTE.

DESCRIPTION OF THE BRÉTE.

This improved method or apparatus is called a bréte (Pl. VI), and it is a simple piece of stout framework which may be made by any farmer if he will give it a little study and get the right materials. Briefly, it is a long chute opening out of a small round corral, and that from a larger one by a gate 12 feet long. This chute is just wide enough for one animal to pass, so he can not turn back or crowd ahead. It has crossbars worked with levers at several places to hold the animals and prevent them from backing out. At one place there is a working frame, where the animal is held securely in the embrace of a yoke (fig. 1) which closes in upon his neck, and any sort of operation may be performed upon him with perfect ease and without unnecessarily hurting the animal or allowing him to hurt himself. Thence he goes to the scales to be weighed, or, if not desired to weigh him, he passes by an adjustable gate into whichever corral his presence is desired. This is a rapid, easy, effective, and humane process, and the expense of building the bréte is not great. Many estancieros make a practice of putting their cattle through it often, so they will be accustomed to being handled. They say it makes them less wild, and they do less running in the pastures.

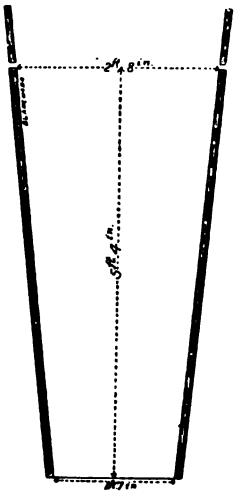

FIG. 3.—Section of the bréte, hardwood posts 6 by 6 inches, sunk 3 feet 6 inches in the ground.

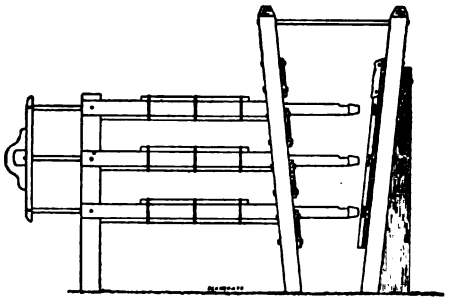

FIG. 4.—End view of bréte with closing bars.

A ground plan of a model bréte on the Estancia Victoria, near Carcaraña, the property of Mr. Henry B. Coffin, a progressive North American breeder, is given herewith, together with some illustrations (figs. 2, 3, 4, and 5) showing how the details are arranged and how the apparatus is operated. The dimensions are given, so that construction may be made from this plan. The whole shows a very

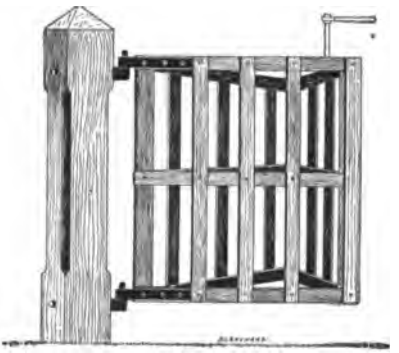

FIG. 5.—Triangular gate at end of the bréte.

conveniently arranged system of corrales for the handling of large numbers of stock where classification is desirable, and this classification is regarded as an important feature of estancia management in Argentina. The woodwork of the bréte should be of strong, straight-grained hard wood, well put together with bolts and iron braces, especially the bréte itself, or working frame, where the animal is handled, so its operation will be certain and quick, with no chance for it to get out of shape.

DEHORNING IN THE BRÉTE.

Dehorning may be done in the bréte better than in any other way, but comparatively little of it is done in the country. The practice is more likely to be that of applying acid to the embryonic horns of calves, if the breeder thinks it worth while to get rid of horns. Many do not see the advantages of hornless cattle and claim that steers can be handled on shipboard better with horns than without. A steer without horns will bring a little more than one that has them, however. Three or four more cattle can be put into a car if they are without horns. They travel in better condition, and the difference in the hides is quite noticeable. The advocates of dehorning are increasing and so is the interest in the hornless breeds, particularly Polled Durhams. The prize fat steers shown in May, 1903, by Dr. Benito Villanueva, were all without horns, and his firm belief in the policy of dehorning has had quite an influence.

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1904

U. S. DEPARTMENT OF AGRICULTURE.

Report No. 78.

AN ENEMY OF THE COTTON BOLL WEEVIL.

BY

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Botanist in Charge of Investigations in Tropical Agriculture, Bureau of Plant Industry.

ISSUED MAY 27, 1904.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1904.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., May 26, 1904.

SIR: In 1902 Mr. O. F. Cook, Botanist in Charge of Investigations in Tropical Agriculture, was authorized to visit Guatemala and other portions of Central America for the purpose of making a special study of coffee and rubber cultivation. During this visit certain data in reference to the growing of cotton was secured, but press of other matters prevented action on a number of suggested lines of work until the beginning of the present year. At this time the Department was making a special effort to obtain cottons for breeding purposes, and some of the discoveries made by Mr. Cook were thought to be of sufficient importance to warrant more extended studies. This matter was discussed by Mr. Cook with the officers of the Bureau, including Mr. Albert F. Woods, Mr. W. T. Swingle, and Dr. H. J. Webber, and upon their bringing the subject to my attention a recommendation was made that Mr. Cook be authorized to proceed to Panzos, Schenaju, Cahabon, and such other points in Guatemala or Mexico as might be necessary for the purpose of investigating and studying the nature of varieties of cottons grown by the Indians which appeared to be resistant to the boll weevil. Early in March Mr. Cook left Washington, proceeding at once to the province of Alta Vera Paz in Guatemala, where his studies were begun. The accompanying brief but highly interesting report of Mr. Cook's work is herewith submitted and it is respectfully recommended that it be immediately published.

From Mr. Cook's report it appears that he has discovered an active enemy of the boll weevil in the shape of an ant which he believes is the agent that makes it possible for the Indians of Alta Vera Paz to grow cotton in spite of the presence of this most destructive enemy of cotton.

Very respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

AN ENEMY OF THE COTTON BOLL WEEVIL.

Specimens of the cotton boll weevil were obtained in eastern Guatemala in 1902. The insects, which were collected on the request of the Division of Entomology, were not found on the cotton cultivated by the Indians, but were very common in the flowers of a tree cotton growing spontaneously near a native house a short distance from the cotton field. The beetles were secured in a rather inaccessible part of Alta Vera Paz, seldom visited by naturalists or other travelers, which lies between Cajabon and Sepacuite and is inhabited only by primitive Indians and a very few Spanish-speaking "natives" of mixed blood.

The Indian variety of cotton seemed very small and unpromising, only one or two bolls being borne on a plant. It seemed very strange also that so small a variety should be planted while the large tree cotton was so ready at hand. It was learned, however, from Mr. Kensett Champney, who has a most thorough acquaintance with the agricultural habits of the Indians, that this was the only variety of cotton planted by them in this district and the one exclusively relied upon to furnish material for their native fabrics. The absence of the weevils from the small Indian cotton was reported when the specimens of the beetles were brought back to Washington, but the diminutive size of the plant seemed to forbid any recommendation of probable utility in the United States.

Later on, with the increasing acuteness of the boll weevil question and the voting of an especial appropriation by Congress for the study of means of protection against the ravages of this insect, the existence of a variety of cotton in Guatemala which seemed not to be subject to the attacks of the boll weevil was recalled, and it seemed to the authorities of the Bureau of Plant Industry that every clew should be followed up. The Secretary of Agriculture authorized an investigation of the Indian cotton of Alta Vera Paz, to ascertain whether it possessed in reality any quality enabling it to resist the boll weevil, or to learn other causes of its immunity from the attack of the insect. The custom of the Indians to plant their crops every year in tracts of land recently cleared by burning suggested an alternative possibility that if not actually resistant to the weevil the cotton might have an almost equally valuable tendency to quick growth, thus enabling a crop to be obtained before the weevils had time to become injuriously numerous. The importance of securing early varieties has been emphasized as the result of the investigations of the boll weevil in the United States.

In this part of Guatemala the present season has been much more rainy than that of 1902, and the cotton is much larger. Well-grown plants bring to maturity from ten to twenty bolls of fair size, and even more. A thorough search shows that the weevil is present and able to injure the cotton, but reveals also an active enemy which keeps it in check. This is a large reddish-brown ant which is attracted to the cotton by the food which it secures from three sets of extra-floral nectaries. Each leaf has a nectary on the under side of the midrib, from 1 to 2 centimeters from the base. Each of the large bracts of the involucre has a circular or broadly oval nectary close to the stem, and there is a third series of three nectaries at the base of the calyx, between the pair of small bracts alternating with the larger divisions of the involucre, of which they seem to be, morphologically speaking, the stipules. Nectar is also to be found between the calyx and the corolla, but no bees, flies, or other winged insects were observed visiting the flowers except beetles, sometimes the boll weevil, but much more often a small black staphylinid of very active habits. To these and to the very small black ants which are also occasionally present in numbers on the cotton, the large brown ant pays no attention, but the weevil is attacked on sight and becomes an easy prey.

The ant's mandibles are large enough to grasp the weevil around the middle and pry apart the joint between the thorax and the abdomen. The long flexible body is bent at the same time in a circle to insert the sting at the unprotected point where the beetle's strong armor is open. The poison takes effect instantly; the beetle ceases to struggle, and with its legs twitching feebly is carried away in the jaws of its captor. As with many other insects when stung by wasps, the paralysis is permanent; even when taken away from the ants the beetles do not recover. The adroit and business-like manner in which the beetle is disposed of, in very much less time than even the briefest account of the operation could be read, seems to prove beyond question that the ant is by structure and by instinct especially equipped for the work of destruction, and is, in short, the true explanation of the fact that cotton is successfully cultivated by the Indians of Alta Vera Paz in spite of the presence of the boll weevil. Instead of congregating in large numbers on the cotton in the immediate vicinity of their nests the ants have, as it were, the good sense to spread themselves through the field, from two to four or five usually being found doing inspection duty on each plant. In some places there seemed to be not enough ants to go around, and here the beetles were more numerous. Rarely, too, certain flowers or branches seemed to have been overlooked, beetles being found on the same plants with the ants. In such instances, indeed, the young flower or boll was generally riddled with punctures as though many beetles had availed themselves of a rare opportunity of feeding undisturbed.

Cotton growing among the Indians is something of a special art, the community being supplied by a few men aware, as it were, of the secrets of the business. They know nothing about the weevil and its ravages, and ascribe such damage as occurs to other harmless insects, or even to superstitious causes, such as the failure of the owner to abstain from salt at the time of planting. The ant, however, is definitely associated in their minds with cotton, and they do not expect to secure a good crop unless these insects favor the plants with their presence. Some of the Indians give the ant a special name, *kelep*, not applied to any other species; but it is also referred to as "the animal of the cotton."

In the neighborhood of Secanquim, on the coffee estate of Messrs. Champney & Co., where most of our observations have been made, the ants are by no means widely distributed, and the cultivation of cotton is confined to very narrow limits, where it is planted year after year in closely adjacent places, or even on the same ground. In one instance the same Indian has planted cotton on the same hillside for upward of forty years, with no failure to secure a crop except in one year, as he explained, when he was sick and did not sow! Such facts preclude, of course, any explanation based on the theory of temporary immunity secured from burning over the land or by planting in a new place in which the beetles have not had time to congregate. The cotton is sowed in October or November, a very rainy part of the year, when land can not be cleared by burning, and the weeds are pulled out and thrown with the dead cornstalks and brush into piles, which would protect the beetles rather than destroy them. The perennial tree cotton also furnishes permanent breeding places, so that the conditions are most favorable to the propagation of the beetles in large numbers. The ants, however, are evidently able to hold them in check, and thus permit the regular cultivation of an annual variety of cotton by the Indians.

Ethnological data shows that the weaving of cotton cloth was practiced in tropical America for many centuries before the arrival of Europeans, and the probability is great that the plant itself is a native of this hemisphere. In being carried to other countries it was taken beyond the reach of both the friends and the enemies which had developed with it. The boll weevil has migrated northward with the extension of the area of cotton cultivation into Mexico and Texas, but the ant has not yet followed. The question now is, whether it can be induced to do so. The Mexican entomologists seem not to have found the ant in that country, in the northern states of which the weevil has been reported as very destructive.

That the ants are so localized in their distribution in this part of Guatemala has undoubtedly served the better to demonstrate their value as protectors of the cotton plant; it suggests also, with other facts, the

probability that they are not native here, but have spread eastward in smaller or larger colonies as the forests were cleared away by the Indians. The present occupation of the eastern districts of Alta Vera Paz by the Indians does not date back more than a few generations, though abundant evidences of much more ancient inhabitants are found in the apparently primeval forests. The ants, like the Indians, probably came from the dry, open interior plateau region, where the center of the aboriginal cotton industry of Guatemala is still located, and where another visit to the ants is to be paid in the next few days. To establish the fact of such an origin for this useful insect would greatly increase the probability of its successful introduction into the United States. The acclimatization of a thoroughly tropical animal requiring continuous heat and humidity could scarcely be hoped for. If, however, the cotton ant can survive a long dry season and perhaps cold weather in the tablelands of Guatemala, it might easily learn to hibernate in Texas, as has the boll weevil. The ant, indeed, is much better able to protect itself against frost, since it excavates a nest 3 feet or more into the ground. That it is a reasonably hardy insect is shown also by the fact that several individuals have survived confinement for twelve days without food, and seem now to be thriving on a diet of cane juice. To take worker ants to Texas will be, evidently, a very easy matter, but to secure queens and establish permanent colonies may require considerable time and experiment and a thorough study of all the habits of the species.

Although the cotton seems to be especially adapted to attract the ant by means of its numerous nectaries, the insect is not, like some of the members of its class, confined to a single plant or to a single kind of prey. It was observed running about on plants of many different families, and it attacks and destroys insects of every order, including the hemiptera, and even centipedes. On the other hand, it does not do the least injury to the cotton or to any other plant, so far as has been ascertained, and it can be handled with impunity, having none of the waspish ill temper of so many of the stinging and biting ants of the tropics. Since where once established it exists in large numbers and seeks its prey actively, it is a much more efficient destroyer of noxious insects than the spider or the toad. It seems, in short, not unlikely to become a valued assistant in the agriculture of tropical and subtropical countries, if not in temperate regions. The farmer has a new and practical reason to "consider the ant."

An accumulation has been made, of course, of seeds, specimens, photographs, and notes bearing on the cotton, beetles, ants, and many other collateral matters not to be mentioned here. Even this brief preliminary report should not close, however, without an acknowledgment of the many favors of Messrs. Owen and Champney, owners of the Sepacuite estate, and of Mrs. Owen. Without the kind invitations, hospi-

tality, and extensive local knowledge and cooperation of these generous friends, it would have been quite impracticable to visit the Indian cotton district of the interior of Alta Vera Paz in 1902, or to ascertain the existence of the cotton ant in the present season.

O. F. COOK,
Botanist in Charge of Investigations in Tropical Agriculture,
Bureau of Plant Industry.

SEPACUITE, GUATEMALA, *May 11, 1904.*

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REPORT

OF THE

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1904.

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REPORT

OF THE

SECRETARY OF AGRICULTURE.

To THE PRESIDENT:

I have the honor to submit herewith my Eighth Annual Report as Secretary of Agriculture.

INTRODUCTORY.

Since my last report progress has been made in securing cooperation with the experiment stations of the several States and Territories; some of the Bureaus of the Department make research in conjunction with all the stations. Preliminary steps have been taken to conduct feeding and breeding experiments in several States looking to the development of breeds of animals suitable to our conditions of climate and soils, and capable of meeting the demands of commerce at home and abroad.

Emergencies arising through the invasion of the cotton-growing States by the boll weevil, a Central American insect that has done much damage in Texas and threatens the entire cotton-growing section of our country, have been met by vigorous work that promises to enable the planters to grow crops in defiance of the pest. The spread over several of the mountain States of a cattle mange required vigorous intervention by the Department. It was necessary to detail a large force of experts to supervise the dipping of the herds in order to eradicate the parasite. Cooperation with most of the States has been arranged, and the rest promise to secure State legislation to compel all flock and herd masters to clean their stock.

The demand in the States for experts to supervise the building of roads suggests the education of engineers in the road laboratory for that work.

The efforts of the Department to create a hardy orange tree that would produce a sweet orange have at last been successful. A hybrid of the Florida orange and Japanese trifoliata has fruited and given us the desired result. Another hybrid gives us an orange very similar to the grape fruit, and a third gives us a fruit equal to the lemon for all practical purposes. Other fruits of these hybrids will be valuable for marmalades and cooking.

Valuable research has been made in fruit shipping to foreign countries; the value of promptly placing fruit in low temperatures as soon as it is taken from the tree is demonstrated.

The value of nitrogen-fixing bacteria has been thoroughly proved, greatly increasing yields of leguminous plants and the accompanying production of nitrogen in the soil.

Progress is being made in introducing plants that succeed in light rainfall localities.

Importers of foods and drinks are obeying the law with regard to adulterations and false labeling.

The elements of agricultural science are gradually finding their place in the primary and secondary schools, through the instruction of teachers.

We buy over $200,000,000 worth of products from tropical countries that can not be grown in continental United States. Through scientists sent from the United States to the several island groups the Department is instructing the people of our island possessions to grow these things, such as coffee, rubber, fibers, drug plants, nuts, fruits, spices, and the like.

Our farmers buy $100,000,000 worth of machinery every year. A better knowledge of its use and care is necessary. Several agricultural colleges are taking up this inquiry, and giving instruction in regard to machinery and farm buildings.

AGRICULTURE AS A SOURCE OF NATIONAL WEALTH.

Favored with continued prosperity in 1904, the farming element of the people has laid broader, deeper, and more substantial the foundations of a magnificent agriculture. These happy results have augmented the similar ones of 1903, so that a period of some industrial depression during the last two years has been saved by the farmers from the severer conditions that must otherwise have befallen in consequence of the absorption of a large portion of the readily convertible capital of the nonagricultural classes into great and prevalent speculations. Thus it has happened the farms of the nation have been that sustaining power upon which a basic dependence must be placed in all stresses by a people endeavoring to maintain economic self-sufficiency.

WEALTH PRODUCED BY FARMERS.

As great as the financial successes of agriculture were in 1903, hitherto without equal, those of 1904 advanced somewhat beyond them. While some products have fallen behind in value others have more than filled the deficit, and the general result is that the farmers have produced in value much more wealth than they ever did before in one year.

One conspicuous item that has contributed to this is the corn crop. With a quantity closely approaching 2½ billions of bushels, near the record crop of 1902, the high price of this year gives this crop a farm value much greater than it ever had before, far exceeding a billion dollars. With this crop the farmers could pay the National debt and the interest thereon for one year, and still have enough left to pay the expenses of the National Government for a large fraction of a year. The cotton crop, including seed, became the second one in value in 1903, and remains so in 1904. It is now too early to state even with approximate accuracy what the farm value of this crop is, but indications are that the farm value of lint and seed must reach $600,000,000. In this case,

as in the case of all other statements herein made concerning crop values for 1904, it must be borne in mind that the amounts have not been finally determined by the Department, that the figures may be considerably changed when the annual estimate is made in the usual way, and that the values are at the farm, and are not commercial values at the exchange or anywhere else.

Hay and wheat are contending for the third place in point of value, although for many years one or the other has held second place or been next to corn. It is expected that these crops, hay and wheat, will together be worth on the farm this year nearly as much as the corn crop, or appreciably more than one billion dollars. Although the wheat crop has a considerably lower production than in any year since 1900, the farm value per bushel is higher than at any time since 1881, so that this is undoubtedly, by a considerable margin, the most valuable crop of wheat ever raised in this country.

It now seems probable that potatoes and barley reached their highest production in 1904; that the oat crop was never so large by 60,000,000 bushels, except in 1902; and that more rice was produced than in any previous year by toward 300,000,000 pounds, so that the present crop of rice has a commercial estimate of 900,000,000 pounds.

The principal crops that are valued annually by the Department or by commercial houses have an aggregate farm value this year which at the date of this writing apparently amounts to $3,583,339,609. The same crops in 1903, as finally estimated, had a farm value of $3,156,099,392 and had a census value for 1899 of $2,526,345,478. In these principal crops, therefore, the farmers find an increase in value for 1904 of 14 per cent over 1903 and of 42 per cent over the census year five years ago.

On account of the difficulty of estimating the present number and value of farm live stock, it must be sufficient to compare the farm equipment in this respect at the beginning of this calendar year as determined by this Department with similar statements made for 1903. Farm horses have increased slightly in number and more in value, and in the aggregate they never were so valuable as in 1904, with a total of $1,136,940,298. The value of farm mules also reached its highest point in 1904, $217,532,832. Cattle have declined a little in number and more in value, and the same is true with regard to sheep and hogs; but the steady advance of poultry in number and in the quantity and value of products leads to some astonishing values for 1904 when the census ratios of increase from 1890 to 1900 are extended to the present year. The farmers' hens are now producing 1⅞ billions of dozens of eggs yearly, and these hens during their busy season lay enough eggs in two weeks, at the high prices of eggs that have prevailed during the year, to pay the year's interest on the National debt.

UNTHINKABLE AGGREGATES.

After a laborious and careful estimate of the value of the products of the farm during 1904, made within the census scope, it is safe to place this amount at $4,900,000,000, after excluding the value of farm crops fed to live stock in order to avoid duplication of values. A similar estimate made for 1903 gives $4,480,000,000, and the census total for 1899 is $3,742,000,000. It is by no means to be admitted that

these figures represent fully the value of the wealth produced on farms. Within the limits of ascertainable values, the farms of 1904 produced an aggregate wealth with a farm valuation that was 9.65 per cent above the product of 1903, and 31.28 per cent above the figures for the census year 1899.

An occupation that has produced such an unthinkable value as one aggregating nearly $5,000,000,000 within a year may be better measured by some comparisons. All of the gold mines of the entire world have not produced since Columbus discovered America a greater value of gold than the farmers of this country have produced in wealth in two years; this year's product is over six times the amount of the capital stock of all national banks; it comes within three-fourths of a billion dollars of equaling the value of the manufactures of 1900, less the cost of materials used; it is twice the sum of our exports and imports for a year; it is two and a half times the gross earnings from the operations of the railways; it is three and a half times the value of all minerals produced in this country, including coal, iron ore, gold, silver, and quarried stone.

FOREIGN TRADE.

In the exportation of their surplus during the year ending June 30, 1904, the farmers of the country kept well up to the high level of recent years. The average annual value of the exports of farm products during the five years 1899–1903 was $864,930,137, and the value for 1904 was but little below, or $859,170,582. The year 1904 was exceeded by only two years, 1903 and 1901, in the value of exported farm products.

On the other hand, the imports of farm products for the fiscal year 1904 were higher in value than ever before, this value being $462,384,570, leaving an apparent balance of trade in farm products in favor of this country of $396,786,012, or the lowest balance in these products since 1897. The balance declined $25,495,220 in 1904. This is accounted for on the side of imports mostly by increases in the imports of coffee, wool, tea, cocoa, and chocolate; and on the side of exports it is accounted for principally by a decrease of over $72,000,000 in the value of exported grain and grain products which was not balanced by an increase of about $55,000,000 in the value of exported cotton.

During the last fifteen years the apparent balance of trade in favor of this country, all articles considered, was $4,384,574,143. This was owing entirely to the balance of trade in farm products, which during the same time amounted to $5,202,551,016, and was large enough to leave the above-mentioned balance of trade after sustaining adverse balances in products other than those of the farm, amounting to $817,976,963.

INCREASE OF FARM CAPITAL.

The subject of the achievements and financial condition of the farming population may be pursued farther. While the farmers have been increasing their annual product of wealth since 1899 from great proportions to still greater ones, the value of their farm property has gone on increasing. Ratios of increase from the last three censuses indicate that since 1900 the farm land with improvements, including buildings, have increased in value 1¾ billions of dollars; the imple-

ments and machinery, over $100,000,000; the principal classes of live stock (corrected by the Department's information), $240,000,000. Hence the apparent total of the increase in the value of farms and farm property within four years amounts to about $2,000,000,000, a total that seems to be under the fact, since it does not recognize the marked increase in cotton, corn, wheat, and other lands with high crop values during the last two years. The cotton crop brought to planters not merely an increased price per pound, but it at once made cotton lands more valuable to the extent of several dollars per acre, according to numerous reports received by the Department.

EVIDENCE OF THE BANKS.

The improved financial condition of the farmer is indicated expressively by deposits in banks in several States in which there is so little manufacturing and mining that the conditions are chiefly created by agriculture. The three agricultural States—Iowa, Kansas, and Mississippi—may be selected for a comparison with the United States as a whole. Individual deposits in the National banks of Iowa increased from June 30, 1896, to October 31, 1904, 137 per cent; Kansas, 212 per cent; Mississippi, 286 per cent; the United States, 92 per cent, or much below the increases of the States named. In the State and private banks deposits during this time increased 128 per cent in Iowa, 227 per cent in Kansas, 306 per cent in Mississippi, and 185 per cent in the United States. In the savings banks of Iowa the increase in deposits was 215 per cent, as compared with 53 per cent for the United States. All kinds of banks being combined, the deposits increased 164 per cent in Iowa, 219 per cent in Kansas, 301 per cent in Mississippi, and 91 per cent in the United States.

A similar comparison favorable to the agricultural States may be made with regard to the number of depositors. In the savings banks of Iowa the number of depositors increased 209 per cent from 1896 to 1904, and in the United States 36 per cent. For National banks, comparison may be made between highly industrial and agricultural States as follows: The number of depositors increased from 1889 to 1903 by 145 per cent in Massachusetts, 117 per cent in New York, 258 per cent in Kansas, and 263 per cent in Mississippi. The increase in Iowa was 184 per cent, the low figure being accounted for by the large development of savings banking.

The Comptroller of the Currency has ascertained the average amount of the daily deposits in National banks, and from his statement it appears that the average daily deposits in October in the National banks of Kansas increased 625 per cent from 1889 to 1903, in Iowa 105 per cent, in Mississippi 89 per cent, in Massachusetts 106 per cent, and in New York 207 per cent.

The farmers' rate of financial progress, as evidenced by the foregoing statements, need fear no comparison with that of any other class of producers. The farmer may not become a millionaire, but he is surer than the millionaire to retain his wealth and to have independence in living.

GENERAL DIFFUSION OF WELL-BEING.

The diffusion of well-being among farmers throughout all parts of the country is one of the most conspicuous features of the recent agricultural development. This attracted attention a year ago and is now

even more noticeable; because the great South is more especially enjoying this growth of well-being, owing to the enhanced value of the cotton crop in addition to the general progress in agriculture. The Eastern farmer, who was long on the verge of bankruptcy in competition with the virgin soil and rapid expansion of the northern half of the Mississippi River Valley, has survived that competition and now enjoys more normal conditions, owing to the creation and maintenance of many large near-by markets by many varied industries. The Pacific Coast has long been prosperous with its world-famed specialties; the mountain States are glad with the fruits and promises of irrigation; in the older prairie States the farmer has seen his land go from $1.25 an acre, or from a homestead gift, to $100 and $150; and the "Great American Desert," as it was called when it was nothing but a buffalo range, is now peopled by a progressive race of farmers, whose banks are filled to overflowing with the proceeds of their products.

WEATHER BUREAU.

OBSERVATORY BUILDINGS.

Carrying out the policy of the Department, the Weather Bureau has continued to cooperate with the leading universities throughout the country, and at the present time the relations existing are more intimate and the work done more important than at any time in the history of the service. Several universities and colleges have donated ground for the erection of buildings. Appreciation of the value of the work being done by the Weather Bureau has also been demonstrated by several universities in placing at the disposal of the Bureau, without cost, office quarters in their buildings for recently established stations. The erection of buildings by the Weather Bureau saves the amount previously paid for rent of office quarters.

FORECASTS.

Weather forecasts for thirty-six and forty-eight hours in advance have been made daily throughout the year for each State and Territory, and special warnings of gales on the seacoasts, Gulf, and Great Lakes, and of cold waves, frost, heavy snows, floods, etc., have been issued when the advices would benefit commercial, agricultural, and business interests. The North Atlantic and West Indian storm-warning service was continued, and forecasts for the first three days out of steamers bound for European ports were issued daily at 8 a. m. and 8 p. m. In a number of instances European shipping interests were notified of the character and probable course of severe storms that were passing eastward from the American coast. Daily warnings and advices issued in connection with the injurious weather conditions of the year resulted in saving much property.

RIVER AND FLOOD SERVICE.

The floods of the year did not approach in character and importance the overflows of the spring of the year immediately preceding, when over 100 human lives were lost, besides property valued at

over $40,000,000. There were, nevertheless, severe floods at various times, and in the management of the work occasioned by them the river and flood service continued to demonstrate its usefulness and growing efficiency as a valuable branch of the Weather Bureau. That there has been constant progress in the accuracy of its work is evidenced by the more specific and detailed character of the forecasts and warnings in localities where such exact work had heretofore been considered practically impossible. The service performed during the prevalence of the great winter ice gorges in the Susquehanna, Allegheny, and Ohio rivers, with their attendant floods, was especially noteworthy. These gorges were the greatest in the history of the localities, and that their great dangers were minimized is due in no small degree to the timely advices and warnings of the Weather Bureau.

There were minor floods during nearly every month of the year, but each was amply covered by timely warnings. These floods were not in any sense alarming or dangerous, but they nevertheless attained sufficient importance to endanger a large amount of property.

CLIMATE AND CROP SERVICE.

The National weather and crop monthly and weekly bulletins and the annual summaries and monthly and weekly bulletins issued from the 143 section centers, also snow and ice bulletins, daily bulletins issued in connection with the corn, wheat, cotton, sugar, rice, and fruit services during the growing season, and the special snow bulletins issued during the winter by the sections in the Rocky Mountain and Plateau regions have appeared regularly during the year and have been of great value in affording timely information.

DISTRIBUTION OF FORECASTS AND SPECIAL WARNINGS.

The extensive distribution of daily forecasts by means of forecast cards has continued, and the railway, telegraph, and train services have supplied in the aggregate over 5,000 railroad stations with bulletins generally posted in the waiting rooms for the benefit of employees and the traveling public. The number of addresses on the rural free-delivery list has been greatly decreased as compared with that of the previous year, owing principally to the discontinuance of the afternoon forecast at some of the centers and the transfer of a large portion of this work to the free telephone service. The rural telephone lines are now the best and most economical means of distributing weather information. The forecasts are quickly disseminated, covering a large territory with little or no expense to the Government. By arrangements made with two of the great trunk telephone lines of Ohio the daily morning forecasts are now available for the use of more than 100,000 subscribers in that State, and the records indicate that nearly one-half of that number have taken advantage of the opportunity to get the forecasts in their homes within a few minutes after their preparation at the district center.

MOUNT WEATHER METEOROLOGICAL RESEARCH OBSERVATORY.

During the past year the main building of the Mount Weather Observatory has been completed, while the power plant, the building

from which balloon ascensions and kite flights are to be made, and the magnetic building are being constructed. The physical laboratory for electrical and radioactive effects is being planned, the erection of which will take place in another year. Finally, a comprehensive physical observatory for photographing the sun directly and through the spectrum, for measuring radiation energy by actinometry and bolometry, with their allied equipment, will be required. This complex institution must grow up slowly as plans can be matured along the best modern lines. When the equipment is ready we shall make and send out apparatus for the exploring of the atmosphere to altitudes of from 3 to 10 miles. It is probable that many balloons will be simultaneously liberated from different stations so as to get records of storms and cold waves from their four quadrants. With observations from the magnetic, the electric, and the solar physics observatories, opportunity for study will be given to those who believe that the cyclonic and anticyclonic whirls that constitute storms and cold waves are mainly the result of changes in the amount or intensity of some form of solar radiation. It is the purpose to make the research at Mount Weather catholic in its broadness.

WIRELESS TELEGRAPHY.

The Department of Agriculture, through the Weather Bureau, was one of the first of the Executive Departments to take up, systematically, experimentation in problems concerned with the development of wireless telegraphy. By this action research into the physical problems concerned in transmitting messages through the medium of ether waves was greatly stimulated in this country. Probably one of the best, if not the best, instruments anywhere made for the receiving of wireless messages had its inception in the experimental work of the Weather Bureau. Recently a board was appointed by you to consider the whole problem of wireless telegraphy and the relation of the Government thereto. Its recommendations, which you approved, will result in the discontinuance of experiments along this line by the Weather Bureau, their transfer to the Navy Department, and the transfer to the Weather Bureau of all the meteorological work now being done by the Navy Department.

LONG-RANGE FORECASTS.

It is hoped the time will come when it will be possible to forecast the weather for coming seasons, to specify in what respect the coming month or season will conform to or depart from the weather that is common to the month or season; but that time has not yet arrived, and the officials of the Weather Bureau have been informed that they will best serve the public interests when they teach the communities they serve the true limitations of weather forecasting.

EDUCATION IN METEOROLOGY.

The Department is interested in the general introduction of meteorology into the courses of study provided by the universities and higher technical institutions of the country. The mode of teaching and the results obtained were made an important part of the work of the

Convention of Weather Bureau Officials which was held at Peoria, Ill., in September, 1904. At an increasing number of educational institutions Weather Bureau officials, in addition to their regular duties and mainly outside of office hours, deliver courses of lectures on meteorology.

TELEGRAPH SERVICE.

To meet as far as possible the pressing demands for a wider distribution of the daily telegraphic reports of observations, arrangements were perfected during the year for a very generous increase in the number of such reports telegraphed over circuits and as special messages, and while for economical reasons it is impossible to satisfy all demands in this respect, it is believed that the present distribution of reports will result in a much more comprehensive display of weather conditions on the maps and bulletins and will give general satisfaction both to the public and to our officials charged with making district and local forecasts. Submarine cables have been laid from Block Island, Rhode Island, to the mainland; from South Manitou to North Manitou Island, Michigan; from Flavel, Oreg., across the mouth of the Columbia River to Fort Canby, Wash.; and preparations are being made for laying one from North Nags Head to Manteo, Roanoke Island, North Carolina.

The reorganization at the beginning of the year of the vessel and wreck reporting service of the Weather Bureau, with additional stations at Sand Key, Florida, and Southeast Farallone, California, has largely added to the effectiveness of this popular feature of the Bureau, and is much appreciated by maritime interests generally. Vessel and wreck reports are now furnished free of charge, except for telegraph tolls over commercial lines, to all corporations and individuals who may apply for them. Besides reporting passing vessels, an important service is rendered by these stations in connection with maritime disasters.

INSTRUMENTAL EQUIPMENT.

The Bureau has now 158 stations completely equipped with instruments by means of which an automatic record is made of the direction and velocity of the wind, the duration of sunshine, the amount and time of beginning and ending of rainfall, and the temperature and pressure of the air. With one or two exceptions the stations that are not at present so equipped are of slight importance, or in general have all the instruments necessary for the satisfactory performance of their work. One hundred and fifty-nine steel towers, with the improved auxiliary equipment for the display of storm warnings, are now installed at as many stations distributed over the shores of the Great Lakes and the Atlantic and Pacific seacoasts. At 77 of these stations high-power electric lanterns are used, and at the others improved oil lights.

BUREAU OF ANIMAL INDUSTRY.

Our animal industry is shown only in small part by the figures giving the exports, yet these exports are so large as to be worthy of notice. The animals exported in the fiscal year 1904 were valued at about $48,000,000, which was an increase over the previous year of

$13,000,000; the exports of meat and meat products, including oleo oil, oleomargarin, and lard compounds, amounted to more than $174,000,000, a decrease of $4,000,000 from the year before. We also sent abroad nearly $6,000,000 worth of dairy products, and of other animal products, such as hides and skins, glue, grease, and grease scrap, over $5,000,000 worth. The exact total of the above items of export, as given in preliminary returns, was $223,023,060, which was an increase over the previous year of more than $12,000,000. The Department is fostering this foreign trade, as well as safeguarding the live-stock industry within our own country.

INSPECTION OF ANIMALS FOR EXPORT.

The inspections of live stock for export included Canadian animals that pass through territory of the United States; these numbered about 26,000 cattle and 60,000 sheep. The total inspections for export, including these Canadian animals, were 790,496 for cattle, 534,850 for sheep, and 3,293 for horses. As compared with similar figures for the fiscal year 1903, this statement shows an increase of 43.7 per cent in the number of American cattle exported and an increase of 116.5 per cent in the number of American sheep exported. The number of horses exported, however, was reduced by one-third.

The percentage of loss in transit for the 360,990 head of American cattle landed at the ports of London, Liverpool, and Glasgow was but 0.17; the percentage of loss for the 212,299 American sheep landed at the same ports was 0.94.

The number of clearances of vessels engaged in carrying live stock was 774, and the certificates of inspection issued for American cattle exported to Europe numbered 1,419.

INSPECTION OF IMPORT ANIMALS.

The work of the inspection of import animals calls for the utmost vigilance in order to prevent the introduction of diseases which might prove disastrous to the live stock of this country. Most of the animals that came through the seacoast ports of entry were imported for breeding purposes, but a considerable number of cattle were admitted from Mexico for feeding. The importations of pure-bred animals subject to quarantine were very light during the year, the number at New York, the chief port of entry, having been 266 cattle, 128 sheep, and 123 hogs. The number of farm animals that came through seacoast ports and not subject to quarantine was 2,492; of this total 2,425 were horses. We brought from Great Britain 1,523 horses, from Germany 204, from Belgium 651, and 47 from other countries.

The importations of animals from Mexico were 12,088 cattle, 701 sheep, 314 horses, and various other animals to the number of 203.

An unusually large number of ruminants for menageries, all of which were subject to inspection and quarantine, were imported during the year.

INSPECTION OF MEAT.

The inspection of animals and animal products was maintained at 51 establishments and cities. The total number of ante-mortem inspections was about 65,000,000, whereas in 1903 the number was about

59,000,000; this shows an increase of 6,000,000 animals. The post-mortem inspections amounted to nearly 40,000,000, which was an increase, except as to sheep, over the year 1903. The increase in 1904 in the number of hogs inspected post-mortem was over 2,000,000.

The meat-inspection tag or label was affixed to 22,943,067 quarters and 120,404 pieces of beef, 8,230,528 carcasses of sheep, 765,301 carcasses of calves, 1,122,193 carcasses of hogs, and 726,779 sacks of pork. Besides, the meat-inspection stamp was affixed to 23,000,000 packages of meat and meat products that had received the regular post-mortem inspection.

Compared with the figures of 1903, the statement for 1904 shows an increase in beef exports of 47,138,044 pounds, a decrease in mutton exports of 2,016,924 pounds, and an increase of pork exports of 21,319,830 pounds—a net increase of 66,440,950 pounds for all.

In the matter of the microscopic inspection of pork there was a great decrease, from 19,000,000 pounds in 1893 to 9,000,000 in 1904. This inspection is restricted to the pork that is destined for those countries which require such safeguard. The number of carcasses thus inspected in 1904 was 315,045. The number of carcasses found to be trichinous was 2,643.

The cost of the ordinary inspection was $781,590.95, and the microscopic inspection cost $53,934.01. Each hog carcass cost 17.1 cents for its inspection and each pound of pork exported 0.6 cent.

CATTLE SCAB, OR MANGE.

The existence of scab, or mange, in cattle has for several years past often been brought to the attention of the Department. As early as the spring of 1901 inspectors in the field recognized that scab of cattle was a contagious disease, and asked for instructions regarding it. The disease continued to spread, and during that year numerous inquiries were received as to how the disease could be cured and controlled. It became generally known that the dipping of cattle was the best method of treatment, and the Department received many calls for information as to the construction of vats and the best dips to use. In January, 1902, a bulletin describing scab of cattle and its treatment was issued. There was a large individual demand for this publication and it was supplied to many State authorities for general distribution.

In spite of efforts to disseminate all the information possible on the subject, the disease spread to an alarming extent, especially on the Western ranges, where the cattle roamed over large areas, and where a few infected animals introduced would communicate the disease to others until the whole band was affected. So extensive was the distribution of the scab that in June, 1903, the Department issued regulations for controlling it, stating that the disease existed among cattle in that part of the United States lying west of the Mississippi River, including the State of Minnesota. These regulations did not apply to the Eastern part of the United States. At that time all of the available funds were used for the employment of inspectors in the Western country in the eradication of scabies among sheep, and there were but a few men who could be used for enforcing the regulations for preventing the spread of scabies among cattle. Many of the Western

States, notably Colorado, began during this year to take measures for suppressing the malady within their limits. These States, however, were unable to prevent the disease from being introduced from other States, consequently very urgent appeals were made from State authorities asking that supervision by this Department be extended to cattle scab.

It was apparent that, unless the Federal authorities undertook measures for its control, the States would suffer disaster, not only from the loss of stock affected, but from the embargo which would be placed upon cattle passing from an infected State to one where the disease did not exist. The disease became so prevalent that it was carried from the ranges to the feed lots in States of the Middle West, and there was danger of injury to the trade in live cattle for export to Great Britain. When the scab became so common on the ranges, it was found that unless the cattle were dipped before shipment the cars in which they were loaded became infected; also the stock pens, where the cattle were unloaded for food and rest en route, as well as the stock yards at the leading markets. It became imperative, therefore, that a campaign should be entered upon, and accordingly in March, 1904, regulations were issued applying to all of the United States and prohibiting shipment of cattle affected with this disease from one State to another.

Provision was made in these regulations for allowing shipment after cattle were dipped, and, though affected with the disease, they could be shipped for immediate slaughter after one dipping; but if cattle were intended for feeding or stocking purposes, they must be held for the second dipping, ten or twelve days after the first one. To secure the enforcement of these regulations, it was necessary to station a large number of inspectors in the Western States, particularly the range States where shipments of cattle originated and where the disease was most prevalent. So far as possible the force of inspectors already in this region was used; but this was entirely inadequate to the demands and required an extensive increase, so that at the present time more than two hundred men are in the field engaged in the inspection of sheep and cattle for scabies.

There was an urgent call for inspectors, mostly from persons who had cattle to ship and those who owned affected cattle which required dipping. This dipping in several States was done in cooperation with the State authorities and under the supervision of Federal employees. Shipments of cattle from ranges known to be infected could not be made to market centers without a certificate showing freedom from scabies, or to the effect that the cattle had been dipped and could be transported without spreading the contagion.

During the first nine months of this year, in the 34 States and Territories where this inspection was maintained, 3,843,075 cattle were inspected for scab; 168,203 were found affected with the disease, and 300,275 were found to have been exposed to it. The total number of cattle dipped during this period, under official supervision, was 420,762; 116,362 affected cattle were given one dipping, and 76,974 affected cattle were dipped a second time, after an interval of ten or twelve days. This work necessarily increases the expenses of the Bureau, which, for the month of January, 1904, amounted to $404.65 for this inspection exclusively, and in September, 1904, to $11,770.70.

FOOT ROT AND GID OF SHEEP, AND RABIES.

Besides the several lines of work which have been carried on through a series of years and which have been reported upon from time to time, special work has been done with reference to foot rot of sheep and the disease of sheep commonly known as "gid." In a recent shipment of sheep which arrived at the Buffalo stock yards 75 per cent were found to be affected with foot rot. This disease is not at all uncommon in the sheep-raising parts of the country, and its eradication is not a very difficult undertaking. A bulletin is now in press which deals with all of the phases of foot rot, and should enable the sheep raiser to clean up his flock without much difficulty or great expense.

Although the conditions prevailing in this country are considered unfavorable to the parasite causing gid, the disease, nevertheless, has gained a foothold in the Rocky Mountain States, and it is therefore well to understand the life history of the parasite causing the disease and the methods of dealing with it. It is reported that a few years ago the loss of sheep from gid in France was as great as 1,000,000 annually. This subject has received a thorough investigation, the results of which will soon be published.

Investigations regarding the presence of rabies, or hydrophobia, in the vicinity of Washington, D. C., were continued during the year. Of the 38 suspected cases examined positive results were obtained from 22, of which number 13 were from the District of Columbia.

TUBERCULOSIS.

The work on the subject of tuberculosis has been conducted throughout the year along lines which have been planned for several years. Some experiments which have been recently reported upon by this Bureau go to show conclusively, it is believed, that it is an error to conclude that cattle can not be infected with human tuberculosis. These experiments not only justify but show the desirability of a rigid enforcement of public regulations looking to the control and the eradication of tuberculosis in cattle.

The demand for tuberculin greatly increased during the year. The amount distributed in 1904 was 74,000 doses, while in 1903 the number of doses was 47,000.

DISTRIBUTION OF BLACKLEG VACCINE AND MALLEIN.

The blackleg vaccine for cattle which is manufactured and distributed by the Bureau of Animal Industry continues to give satisfactory results. During the year the number of doses that were sent out fell off somewhat from the report of the previous year, but the number of persons supplied was slightly increased. It is interesting to note that, in 1904, 1,000,000 doses of the vaccine were used and reported upon by over 10,000 persons with highly satisfactory results. After a careful analysis of the figures which were compiled from the reports from the users of blackleg vaccine, and eliminating the deaths which could in no manner be properly charged against the action of the vaccine, the number of cases that died after vaccination is reduced to the very low figure of 0.44 per cent.

The manufacture and distribution of mallein in 1904 for glanders in horses was about the same as in the previous year, and the number of doses sent out was 7,000.

INSPECTION OF DAIRY PRODUCTS.

Under the act of Congress approved May 9, 1902, the Bureau of Animal Industry is charged with the inspection of certain dairy products which are designed for interstate commerce, especially the article of renovated butter. This work is now fully organized and is governed by joint agreement of the Treasury Department and the Department of Agriculture. The reports for 1904 show that there were 73 factories licensed and bonded, which was a reduction of 9 from the previous year. These factories were located in 14 States and the District of Columbia. The quantity of renovated butter made at bonded factories during the fiscal year of 1904 was about 54,000,000 pounds. The average quality of renovated butter is improving. The difference in general character, since the inspection was inaugurated, is very marked. This is due, in part, to improved machinery and processes, and largely to the better average quality and condition of the "packing stock" or raw material used.

Such stock is now closely collected in the producing districts, so that accumulations of country butter at remote points and involving deterioration are not frequent. More care is taken in sorting, packing, and storing the stock. Occasionally a lot of packing stock is found in such a condition of filth or putrefaction as to necessitate condemnation. In still rarer cases the manufactured product is found to be so bad, because of bad materials, ignorance, or negligence in renovating, or as the effect of age, as to make it unfit for food. In a few such instances the sanitary inspection required by law and made by this Department has caused the objectionable materials and products to be removed from the food market and sold as grease. But, as stated, such instances are not frequent. Although there is still opportunity for great improvement in materials, in the manner of handling and transporting the same, in factory management, and in the finished product, it is true that the manufacturers are endeavoring, as a rule, to improve conditions at all points and are ambitious to win a reputation for producing an article of high quality.

BUREAU OF PLANT INDUSTRY.

In no field of industrial work have there been greater advances during the past decade than in the improvement of plants and the methods of growing them. The Bureau of Plant Industry has done much to bring about these advances. Diseases have been studied and remedies found, new varieties of plants have been created and new industries established, and the world has been searched for better things, all for the purpose of helping the farmer and making his work less burdensome and more profitable.

GROWTH OF THE WORK.

Since the Bureau of Plant Industry was organized, three years ago, the demand for more work has been so great as to require an increase of nearly 50 per cent in men and funds to conduct it. There are now in the Bureau about 500 workers, 60 per cent of whom are engaged in scientific investigation and its application to the farm, the orchard, and the garden. The Bureau is endeavoring to train young men as rapidly

as possible for this work. The agricultural colleges furnish a part of these men, but the demand for those with proper qualifications is still greater than the supply.

ENCOURAGING INTEREST IN FARM LIFE.

The Department is not an educational institution in the strict sense of the word, but it can do and is doing much to bring home to the people in all walks of life the importance and value of the farm and its productions. The Bureau of Plant Industry is making a special effort to encourage the study of plants in the public schools. The future welfare of this country depends upon its agricultural development, and it is important and vital that a knowledge of the opportunities in this field should early be brought to the attention of the child. Unfortunately, our system of elementary education is such as to leave no impression on the child's mind of the importance, value, and usefulness of farm life. The child is, in many ways, brought early into contact with facts which point to him the value of commercial life. He is, therefore, early inoculated with the belief that to reach the highest possibilities he must, if he is on the farm, migrate to the city. It is to be regretted that farm life in the past has not always been conducive to the encouragement of young men to remain on the farm.

Very little effort has been made to overcome the general belief that there is always a great amount of drudgery connected with the farm, and that the opportunities in this sort of occupation are narrow and limited. When we see the rapid advances that are being made in agriculture along all lines and note the need for bright young men in this field, the opportunities offered by the cultivation of the soil seem as great as in any other field. In order to bring these matters clearly home to the children, efforts are being made by the Department to encourage the growing of plants in connection with the public school work. The general distribution of seed is being handled in such a way that the encouragement of plant growing will be a feature of it. Wherever it has been practicable to influence school authorities, this has been done. Various members of the staff of the Bureau are constantly endeavoring by publication of papers, lecturing, etc., to point out the advantages of rural life.

DEVELOPING NEW INDUSTRIES.

RICE PRODUCTION.

The Bureau of Plant Industry has continued its efforts to encourage rice production in the Southern States, especially in Louisiana and Texas. A special farm for the growing of rice has been placed at the disposal of the Department, and upon this farm various questions relating to the industry are being worked out. New varieties of rice are being tested, questions pertaining to the best methods of improving the seed are being settled, and other important problems are under investigation. There has been an enormous increase in the production of rice in the States of Louisiana and Texas during the past three years. As the industry has developed, the necessity has become more and more evident for paying special attention to the improvement of cultural methods.

In the early days of the industry the crop was so profitable that little attempt was made to obtain information on important matters, such as the necessity for rotation, the best methods of handling the water, means of controlling diseases and weed pests, and other important subjects. As competition has become greater and the production larger, farmers are realizing the necessity for paying strict attention to all details connected with the work. Preliminary estimates show that during the year 1904 the area devoted to rice in Louisiana and Texas was 600,000 acres, and the crop will approximate 650,000,000 pounds of rough rice.

DURUM WHEATS.

The success attending the introduction and growing of the durum or macaroni wheats continues unabated. The past season has been a particularly trying one for all wheats in the Northwest. Rust has caused great damage in many localities, but the durum wheats have been in most cases resistant. Probably no less than 14 million bushels of these wheats will be grown the present season, and the evidence at hand indicates that great quantities of the wheats are being saved for seed for next year's planting. Owing to the almost total loss of other wheats east of the area where the durum wheats succeed best, efforts will probably be made next year to plant the durum wheats farther east than they should be planted. It must be remembered that these wheats are specially adapted to semiarid regions, and moving them into humid regions may result in disappointment.

It is gratifying to announce that the durum wheats are now being handled without difficulty by many of the millers, and regular grades corresponding with the grades of other wheats have been established in the markets. From the outlook at present there will be not less than 40 or 50 million bushels of these wheats produced next year. The fact that these wheats are valuable for bread and that they can be grown successfully where most other crops fail is an exceedingly important thing for the agricultural development of the great semiarid West.

THE MATTING INDUSTRY.

The United States imports large quantities of mattings from the Orient. These mattings, for the most part, are made of a species of rush which might easily be grown in this country; in fact, there are already here several native forms which undoubtedly would prove valuable for the manufacture of fine mattings. Special American machinery has been devised and is now in use in the manufacture of a very high grade of mattings. So far, the raw material used by these machines has been imported. During the year the Bureau of Plant Industry has introduced and disseminated considerable quantities of the rush, with the object of securing a sufficient amount to supply American manufacturers with the product. The results accomplished have already proved encouraging, and the work will be continued.

SUGAR-BEET GROWING.

The development of the sugar-beet industry continues satisfactory. The Bureau of Plant Industry is making an effort to improve the conditions affecting this crop in the matter of providing better seed,

encouraging the use of fertilizers where fertilizers are likely to do good, studying the diseases with a view to discovering remedies for them, securing improvement in the matter of seed by the production of beets which will give seed of a single ball or germ, etc. A little more than two years ago the Department again took up the work of establishing sugar-beet seed culture in the United States, and since that time work has been going on in four representative sections of this country. Strains of pedigreed seed are being established in New York, Michigan, Utah, and Washington State, while in Utah and Washington the industry is already assuming commercial importance.

In California also seed is being produced for local use. In Washington State 80,000 pounds of seed were produced in 1904, in Utah about 32,000 pounds, and in California about 50,000 pounds—a total of 162,000 pounds. As rapidly as the Department can bring home to all the sugar-beet factories the conviction that American-grown seed is as good and often better than the imported, these quantities will be increased, and it is a question of but a few years when the entire 5,000,000 pounds used in the United States will be produced at home.

As to the quality, American-grown seed has produced beets testing as high as 24 per cent of sugar, while the average percentage in all beets tested from American-grown seed during 1903 was 15.8 per cent. The average percentage of sugar in all beets grown in the United States, as shown by the factory returns of their total extractions, is a little over 11 per cent. It will be remembered, too, that the American seed has the benefit of only two years of careful selection. The work of establishing a pedigreed strain is slow, and years are required for the completion of such an undertaking; but the work is so far along that its success may be considered assured.

Two years ago the Department imported all the sugar-beet seed that was distributed for experimental purposes, while during the 1904 season 14,000 pounds of American-grown seed were distributed by the Department to selected farmers for testing in comparison with imported seed furnished to them by the factories. The reports on the stand secured, which is generally indicative of the yield, show that the American seed gave almost without exception a greater and a stronger growth than the imported seed. In a number of instances those portions of fields which were sown with factory seed gave such a poor stand that they had either to be resown or abandoned, while the portions sown with American-grown seed gave good stands and in no case required replanting. The factories during 1904 bought 34,500 pounds of American-grown seed, and a number of these factories are now negotiating with the American growers for contracts to supply the seed they need.

In the fertilizer work efforts have been made to determine the effect of different fertilizers on tonnage and sugar content, and also their influence on various diseases.

Investigations along this line were undertaken in six sugar-beet States, seven brands of complete fertilizers being used, and in addition some separate experiments with the various ingredients used by themselves were made. The preliminary reports which have been received indicate that in many cases the effect of the fertilizers could be seen from the time of the germination of the beets. In a few cases the lines separating the fertilized from the unfertilized plots could be seen even at the beginning of the harvest. A recent report from one

of the experimenters states that in his work with nitrate of soda the beets from the untreated plots were worth $5.20 per ton and yielded $54.35 worth of beets per acre. On the adjacent plot, where 300 pounds of nitrate of soda were applied at the time of planting, the beets were worth $5.30 per ton and yielded $74.57, a difference of $20.23 per acre in favor of the fertilization. The untreated beets tested 14.1 per cent sugar, while those fertilized tested 14.4 per cent.

The serious epidemics which have affected the sugar beet, like the leaf-spot disease of the East and the curly top of the West, have been investigated. Experiments on a large scale in different sections of the Eastern beet area have shown that the leaf-spot may be readily controlled by the application of Bordeaux mixture. This remedy has now come into general use.

In my last report attention was called to the efforts being made in the matter of developing sugar-beet seeds with single germs. The single-germ seed would do much to diminish the labor of thinning. The Bureau work in this field has been very satisfactory. Although the work has been running for only two seasons, decided progress has been made, and the single-germ seeds that have been selected have been found much more vigorous than the multiple-germ balls. The selected strains grown this year show a decided tendency to the production of a larger number of single-germ balls than the parent beet from which the selection was started, the average gain being about 20 per cent. In one case, over 3,000 single-seed balls were found on one beet. The work this year has been conducted in Utah and other sections where the sugar beet is at its best, and indicates that ultimately we shall in all probability be successful in the production of a beet having the desirable quality of producing only balls with single germs, that will substantially save hand thinning and avoid much expense in growing.

NEW CITROUS FRUITS.

The efforts that have been made by the Bureau of Plant Industry for a number of years in the matter of producing, by breeding, new citrous fruits, so as to build up varied industries in the South, have met with very gratifying results. The hardy sour oranges which have been secured as a result of crossing the sweet orange with the hardy Japanese orange are now ready to distribute, and the work of distribution will be inaugurated in the coming winter. These new hardy oranges will unquestionably make possible the development of several important industries in the South. The oranges are valuable for marmalades, and from the fact that they may be grown in nearly all the Southern States, great possibilities for their usefulness are opened up. Even if they should not come into general use for manufacturing purposes or for general orchard planting, they will undoubtedly eventually become a feature in every dooryard throughout the South. Aside from their value for the manufacture of marmalades and preserves, they will be exceedingly useful for pies and other purposes.

There has been fruited this year for the first time a sweet orange of the hardy type. This is an accomplishment which the Department hoped for when it first inaugurated the work. The other new citrous fruits developed from the Bureau's investigations, such as the new tangelo, which is a cross between the tangerine and the pomelo, a new velvet-skin orange, and several other creations, will all prove exceed-

ingly valuable in sections where the climatic conditions will permit the growing of these more tender sorts.

AMERICAN TEA.

The Department has continued its work in the production of American tea. The more advanced investigations have been conducted, as heretofore, at Summerville, S. C., in cooperation with Dr. Charles U. Shepard. Doctor Shepard's tea gardens are now yielding from 8,000 to 10,000 pounds of tea annually. Owing to climatic conditions the crop this year will be light. Doctor Shepard has been devoting special attention to the improvement of factory processes. Several new inventions have been made by him in the matter of tea rollers, apparatus for the manufacture of green tea, and apparatus for a process of attrition, giving to the tea the beautiful bluish cast, or finish, which heretofore has been secured in foreign countries by the application of various chemicals.

Doctor Shepard's process puts this finish on the teas by simple attrition or friction, and is a marked advance over the old processes. The work of establishing a plantation in Texas has been continued. Tea beds were started on two types of soil—a rich sandy loam and a black, waxy soil. The plants on the black, waxy land have failed utterly. Fortunately this discovery was made before any extensive plantings had been undertaken, and it will lead to the extension of the plantings on the sandy loam soil. There are now on hand at our Texas station, which is located at Pierce, about 100,000 plants, which will be put into the field this winter, planting about 40 acres. Sufficient additional seed will be put out to give another 50 acres next year.

AMERICAN DATES.

Encouraging results have been secured in the establishment of this industry in the southwestern portion of the United States. The date orchard at Tempe, Ariz., is progressing in a highly satisfactory way. The work here has been carried on in cooperation with the Arizona experiment station and has been under the direct supervision of Prof. R. H. Forbes. In cooperation with the California experiment station, work on the establishment of date culture in southern California is also being conducted. Ten acres of land have been secured for an experimental orchard and dates have been and are being planted there. The industry has been further encouraged by the publication of important reports on the subject, pointing out available localities where the crop is likely to succeed. There is a considerable extent of territory in southern California where practically all of the dates of a certain class which are now imported could in all probability be grown. These regions have been mapped and a special effort has been made to encourage the production of the crop therein. Various importations of the date have been made during the year and others will follow from time to time as the industry advances.

BULB GROWING.

The very specialized conditions of soil and climate necessary for the proper production of bulbs and the peculiar nature of the skilled labor required have made the establishment of the bulb industry difficult.

However, investigations have shown that nearly all of the so-called Dutch bulbs may be grown in the United States, and that one by one the difficulties due to competition of cheap skilled labor, excessive cost of transportation, and the natural hesitancy on the part of purchasers to use an untried article will be overcome. A method has also been discovered by the Department experts to produce the Bermuda lily bulb free from disease. Of the millions of lily bulbs annually imported, it is safe to say that 40 per cent are more or less affected by disease. The eventual elimination of this trouble will be due to the work of the Department.

AMERICAN-GROWN DRUG PLANTS.

In Vermont, the previous success in growing opium poppies has been repeated with even more satisfactory results, both the white-seeded and blue-seeded sorts giving good crops. The attempt to cultivate this plant has been made with the object in view of testing the possibility of developing in this country a means of supplying our demand for poppy alkaloids for medicinal uses. The present source of these—morphine, codeine, etc.—is to be found in crude opium, of which approximately a million dollars' worth is imported annually. The cost of these products is in large part due to the labor involved, and the efforts of the Bureau have been directed toward devising some process whereby the alkaloidal principles can be isolated directly from the extracted juices of the plant. Up to the present time no one has succeeded in obtaining morphine from these extracts.

During the year an expert of the Bureau has, however, met with success, and we are now able to obtain morphine directly from the expressed juices of the plant. This method does away with much of the expense. Experiments are now being undertaken to ascertain the practicability of obtaining morphine directly from the plants as a commercial source. If the experiment indicates a favorable outcome the plants produced in American fields will replace oriental opium as a crude source for morphine.

SWEDISH SELECT OAT.

The experiments of the Department with this hardy Swedish oat ceased some time ago, but highly interesting reports in regard to its usefulness are still coming in. It was introduced about five years ago by the Bureau of Plant Industry and distributed in a number of the Northwestern States. It has high qualities as a yielder and is especially valuable for resisting drought.

It has now become the most popular variety in the States of Wisconsin, North Dakota, Montana, portions of Idaho, South Dakota, and Minnesota. In one instance in Wisconsin, from the planting of 33 grains in the spring of 1899, there resulted a production of about 20,000 bushels in the year 1903, and a half million bushels in the present year, 1904. It is expected that the present year's crop will show that about 4 million bushels of this oat are being produced in Wisconsin. Although the highest legal weight of oats is 36 pounds to the bushel, this variety commonly weighs from 40 to 44 pounds in the Northern States, and occasionally reaches from 48 to 50 pounds to the bushel.

SPECIAL WORK ON COTTON.

The Bureau of Plant Industry has made a special effort to aid the farmers of Texas, Louisiana, and other Southern States where the Mexican cotton boll weevil has already appeared or is likely to appear. In all sections the energies of the Bureau have been put forth to encourage better methods of farming, with highly gratifying results.

COOPERATION WITH FARMERS.

With a view to bringing directly home to the farmers of Texas and Louisiana, especially those in the boll-weevil districts, the advantages of better methods of cultivation, the value of early maturing seed, etc., the Bureau organized an extensive line of propaganda work. The farmers in the various counties were organized and were brought into cooperation in such a way that large plantings were made under the direct supervision of the Department. Tracts of 5, 10, 15, and 20 acres were handled by individual farmers, under working plans furnished by the Bureau, the object being in all cases to demonstrate the practicability of growing cotton despite the presence of the weevil.

More than 5,000 farmers were engaged in this work, and the results have been highly satisfactory. At a recent meeting held in Houston, where more than 200 representative farmers from all parts of the State were present, records were presented showing the yields of cotton under the plans of the Department compared with old methods. The increased yields, ranging all the way from 25 per cent to 100 per cent in districts badly infested by the weevil, show that by proper methods of culture, the use of early maturing varieties of seed, and the application of proper fertilizers excellent results may be obtained. A complete record of the yields from the various farms conducted under the direction of the Bureau has been kept, and a report embodying these data will soon be published.

COOPERATION WITH THE TEXAS AGRICULTURAL COLLEGE.

In the special work on cotton the Bureau of Plant Industry has been in the closest cooperation with the Texas Agricultural College. The president of the college has taken charge of the farmers' institute work, and with the aid of several men selected by him and men furnished by the Department all parts of the State were visited early in the spring, and the necessity for giving strict attention to better methods of cultivation was set forth. This institute work will be continued during the present autumn and winter. In addition to the institute work, the Bureau has been cooperating with the college in the matter of the breeding of cotton, the testing of fertilizers, and other important lines of investigation. Thorough harmony prevails, and every effort is being made by both the Department and college officials to make the work effective.

COOPERATION WITH LOUISIANA AUTHORITIES.

Cooperation has also been secured with the Louisiana authorities, and a number of important lines of work have been carried on in the State. The propaganda work, as described for Texas, has also been conducted in portions of Louisiana. Demonstration work with fer-

tilizers has been carried on; also other investigations having for their object the encouragement in every way of better methods of farming in advance of the approach of the weevil.

DIVERSIFICATION FARMS.

As another feature of the work in the South, plans were made and put into operation establishing diversification farms at various places. The object of these farms was to show the value and importance of diversified agriculture. It was found unnecessary for the Bureau to expend any funds in the development of these farms, except in minor ways for the purchase of certain special seeds, and sometimes for special fertilizers where such were to be used. In all cases the business interests of the respective communities gladly cooperated with the Bureau to the end not only of securing a desirable farm for the purpose, but assuming all responsibility for its support. In every instance efforts have been made in organizing these farms to make them not only self-supporting but profitable. The main object of the work is to show that by diversified agriculture the lands may not only be improved, but more money can be made than in farming with a single crop.

Thirty-two of these farms have been or are about to be established, of which 16 are in Texas, 5 in Louisiana, 3 in Georgia, 2 in Alabama, 3 in Mississippi, 2 in South Carolina, and 1 in Florida. The general method employed in locating, organizing, and conducting these farms is to first determine in what section of the State the various farms are to be located. An effort is then made to find a progressive farmer who is desirous of encouraging diversified farming in his section, and who is willing to permit the Department to aid him in doing it. When a suitable arrangement has been made, a representative of the Department and the State experiment station make a thorough study of local conditions with reference to cropping possibilities, markets, advantages, etc. A system of records is instituted, which enables the Department to secure detailed information regarding every phase of the management of the farm and the results secured. After the farms are established, other farmers are encouraged to visit them, this being done largely through the cooperation of the State experiment stations.

BREEDING NEW TYPES OF COTTON.

Extensive work has been inaugurated in Texas having for its object the breeding of new types of cotton better adapted to meeting the conditions brought about by the invasion of the weevil. More than 100 varieties of cotton have been grown and many selections have been made. This is necessarily slow work, but already very encouraging results have been secured in the matter of obtaining earlier and better yielding types—types that are better able to resist storms and types for special purposes in several regions.

DISCOVERY OF THE GUATEMALAN ANT.

During the year an important discovery was made by an officer of this Bureau, viz, the discovery in Guatemala of an ant that destroys the weevil. Eighty-nine colonies of these ants were brought into

Texas and are now being thoroughly studied with a view to determining their value as a means of checking the serious inroads of the cotton insect. After the introduction of the ant by this Bureau further work on its distribution, habits, etc., was placed under the Bureau of Entomology.

WEEVIL-RESISTANT COTTON.

Another and perhaps more efficient method of combating the boll weevil than by means of the ant has been discovered very recently. The hope of finding a variety of cotton not subject to injury by this pest has been cherished for several years, but hitherto no method has been ascertained by which the plant could offer effective resistance to the insect. It has been found, however, that in some varieties of cotton the presence of the larva, instead of blasting the buds and bolls, often stimulates a special growth of internal tissue which kills the young weevil. This is not merely accidental or abnormal, but is in the nature of a protective adaptation developed as a final result of a long struggle for existence between the cotton and the weevil in tropical America. The insect could not breed or perpetuate itself in the presence of a variety of cotton in which the formation of the new protective tissue occurred regularly. It is accordingly within the range of scientific possibilities that resistant varieties of cotton can be found in tropical America or developed by selection, and work on this line has been begun.

DISTRIBUTION OF EARLY-MATURING VARIETIES OF COTTON SEED.

With a view to encouraging the planting of early-maturing varieties of cotton, such as King and Parker, a large distribution of these varieties was made in the State of Texas and a portion of Louisiana during the year. Small quantities were sent to farmers, the cooperation of Senators and Members of Congress being secured for the purpose of distribution. Records have been kept of all the farmers who received this seed, and reports are now being returned to the Department as to its value as compared with ordinary sorts. In most cases very encouraging reports have been received as to the use of the early-maturing seeds, and the chief value of the work will be in the fact that from this distribution the farmers themselves may start the selection of stock seed for future planting.

INVESTIGATION OF THE COTTON ROOT-ROT.

As a feature of the work in Texas a special effort has been made to obtain information as to the best methods of combating the cotton root-rot. This disease has been very serious the past season, destroying large areas of cotton in many portions of the State. Efforts have been made to secure resistant types, but so far the results obtained have not been very encouraging, although some progress has been made. Experiments have been made for the purpose of determining the value of soil treatments, seed treatments, and other methods of combating this disease, including crop rotation. This work has just been started, and it is too early yet to determine its value.

PROGRESS IN COMBATING PLANT DISEASES.

CRANBERRY DISEASES.

Important advances were made during the year in the matter of treating cranberry diseases. The cranberry crop is an important one in this country, aggregating in value a million dollars or more annually. In recent years several destructive diseases have caused a great deal of damage, and until the Department began its investigations little progress had been made in the matter of treatment. Experiments the past year in the treatment of one of the most serious diseases, commonly known as "scald," have been quite successful. It has been demonstrated that this particular disease may be prevented by the application of fungicides at very small expense.

ERADICATION OF LITTLE-PEACH DISEASE.

The efforts made by the Department in the matter of demonstrating the feasibility of eradicating the little-peach disease from the orchards of Michigan and other States have been continued on a large scale. A section 3 miles square in Michigan was selected for this work and the orchards were thoroughly gone over three times during the months of July, August, and September and all of the affected trees were destroyed. The object of this experiment is to demonstrate what is believed to be a fact, viz, that the disease can be entirely eradicated by the extirpation process.

WINTERKILLING OF FRUIT TREES.

The extreme cold of the past winter caused the extensive killing of fruit trees in many portions of the Northern States. At the approach of spring the trees had the appearance of being seriously injured, and undoubtedly a great many would have been destroyed but for the timely aid rendered by the Department in the matter of suggesting proper means of handling such injuries. A brief report was issued as a guide to the owners of the frozen trees, and this undoubtedly saved many orchards from needless destruction.

DISEASES OF TOBACCO.

The most serious disease of tobacco in the United States during the past season has been the new malady called "wilt." This has been very destructive in certain portions of the South, and so rapid has been the spread of the trouble that it threatens the complete destruction of the large tobacco industry in North Carolina. Evidence is at hand that this disease is very similar to other wilt troubles, and that it may eventually succumb to treatment through the selection and development of resistant types. Work with a view to securing these types is now being conducted.

WILT DISEASE OF COTTON.

The success of this Bureau's wilt-resistant varieties of cotton was more marked last season than ever before. An improved selection from the Rivers cotton remained entirely free from the wilt on the worst infected land on James Island, South Carolina, where the finer types of Sea Island cotton are grown. These cottons, originating

through the efforts of the Department, are not only wilt resistant but have a finer and better staple than the original nonresistant strains, thus disproving the assertion that resistance to wilt had been obtained at the sacrifice of quality. Considerable quantities of the seed of resistant and desirable strains of cotton have been obtained and distributed. In connection with this work the wilt of the cowpea has also been studied and resistant types secured and distributed. About 200 bushels of the resistant cowpea seed were sent out last spring. This work is being developed as an auxiliary to the cotton investigations, as it has been found that many thousands of acres of sandy soil in the Gulf States are infected by both the wilt and root-knot, and the cultivation of the ordinary cowpea results in great injury to the cotton.

ADVANCES MADE IN FORAGE-CROP WORK.

ALFALFAS AND CLOVERS.

Alfalfa has attracted more attention on the part of farmers in the eastern half of the United States during the past two years than any other crop. The Department has demonstrated that it can be grown in almost every State in the Union. Varieties have been found which withstand the rigorous winters of the northwestern prairie States. Other varieties have been found which are immune to the alfalfa leaf rust. There is still much to be learned concerning the adaptability of alfalfa to various types of soil in the Eastern States, and much time is being devoted to the solution of this problem. The cultural methods required for establishing and maintaining alfalfa meadows are also receiving due attention. The subject of clover sickness, a matter of very great importance to farmers throughout the clover region, is being investigated. New varieties of clover which appear to possess some advantages over the standard varieties grown in this country have been secured and are being propagated with a view to introducing them generally in the clover region as soon as sufficient seed is available. Some of our native clovers are being grown under farm conditions in order to determine whether or not they are worthy of domestication. One or two of them are promising, particularly for sections of the country where red clover does not thrive.

SOIL AND SAND BINDERS.

Methods of holding drifting sand in place have been thoroughly worked out. An agent of the Department has made a careful study during the past two years of the methods which have been developed in Europe in work of this character, and demonstrations of these methods are now being made in portions of the country where drifting sand is most troublesome. Attention is also being given to plants adapted to hold banks and the sides of cuttings in place, and several plants which possess high value for this purpose have been found. This work is of particular interest to civil engineers, and in prosecuting it the most hearty cooperation from them has been received.

RANGE INVESTIGATIONS.

During the past year a large amount of information regarding the carrying capacity of the ranges in various parts of the West has been collected. The fact that intelligent management will bring the ranges

back to their primitive state of productiveness has been established. For two years past an area of fenced range in Arizona, in which all types of range land are represented, from absolute desert to good mountain range, has been under careful observation. Two years' protection from stock has sufficed to make this range nearly as productive as it was in its virgin state. The methods of management used by parties who own or control considerable areas of range land are being studied. It is considered to be definitely demonstrated that there is no chance of improving range conditions except where stockmen are enabled to control the ranges upon which their stock feed, and data are being collected which will furnish valuable information as a basis for legislation concerning range lands. It has been demonstrated that a number of species of plants may be introduced upon the ranges by practicable means.

In nearly all cases the plants which have been of value for this purpose are annuals producing large quantities of seed. The possibility of introducing other plants upon the range is still being investigated. In this connection a careful study of the large collection of annual grasses from Europe in our extensive herbarium is being made, with a view to finding species which appear to be adapted to conditions on our Western ranges. Arrangements have been made whereby seed of some of the most promising of the species may be secured for use in the investigations of this subject. It has been demonstrated that in the mountain ranges where there is considerable rainfall a number of standard grasses and clovers may be established upon the range by methods that are entirely practicable. In the mountain region in the State of Washington, by protecting the range from the depredations of nomadic herds of stock, the Bureau has been able to establish such grasses as timothy, redtop, bluegrass, and white clover, thus adding enormously to the productive capacity of these ranges. During the year much assistance has been rendered to ranchers by outlining methods of handling their ranches.

THE CACTUS AS A FORAGE PLANT.

Much of the range country is covered with a sparse growth of cactus, which for the most part is looked upon by stockmen as a nuisance. During the past year a number of methods have been found by which the cactus plant may be utilized to advantage as stock feed. The value of the more promising species for forage purposes, the length of time required to mature a crop of cactus on land from which the old growth has been harvested, and the feasibility of establishing cactus plantations where they may be needed are now being investigated.

ALKALI-LOVING PLANTS.

The increase of the area of alkali lands in the irrigated districts of the West has given added importance to plants that may be grown upon such lands. Several such plants are available, and the Bureau is investigating the forage value of these plants, as well as methods required for their cultivation. A few years ago the Australian saltbush was shown to be adapted to lands of this character, and a great deal of interest in this plant was aroused among Western farmers. Recent investigations by the Bureau indicate that the cultivation of the plant

has practically ceased. There is no question of the value of the Australian saltbush as a forage plant or of its adaptability to strong alkali lands. The principal difficulty with the plant seems to be that proper methods of utilizing it have not been worked out. The Bureau has undertaken to find what place it can be made to occupy in Western agriculture and the methods by which farmers can take advantage of its demonstrated value. Considerable areas of a number of other forage plants known to be adapted to alkaline conditions are being grown with a view to determining their forage value.

INVESTIGATIONS OF GRASSES, FORAGE PLANTS, AND STOCK FEEDING.

The office of Grass and Forage Plant Investigations is now in possession of the varieties of timothy developed by Dr. A. D. Hopkins. Some of these are greatly superior to timothy as ordinarily grown by farmers. They are being propagated with a view to making the seed available, which it is hoped will be within two more years.

Mr. A. B. Leckenby, director of the Eastern Oregon experiment station, has kindly turned over to this office 23 varieties of *Bromus inermis* secured by him during the past two years. These are being grown with a view to rendering the best varieties available for distribution.

The separation into varieties of such standard grasses as redtop, Bermuda, orchard grass, and meadow fescue has been undertaken. Work of this character already done indicates that all of our standard grasses are really mixtures of a large number of established varieties. Some of these varieties are much superior to the grasses ordinarily grown. It is hoped within a few years to be able to offer farmers small quantities of seed of improved forms of all the standard grasses.

WEIGHT AND VOLUME OF HAY.

The office of Grass and Forage Plant Investigation has shown that the ordinary rules in vogue for determining the volume of hay in the stack are not reliable, and it has developed formulæ that give reliable results. It is now investigating the number of cubic feet of hay per ton for hay under various conditions as to kind of hay, size of stack, and length of time it has been in stack.

DOMESTICATING NATIVE GRASSES.

A considerable number of native American grasses have shown themselves to be adapted to regions where at present hay grasses are wanting. Several of these are being grown under field conditions during the present season with promise of success. The Bureau is gathering a considerable quantity of seed of other grasses this year and will give them a trial, particularly in the semiarid portions of the West, at the earliest opportunity. It is believed that hay grasses can be found for the Western plains where the average annual rainfall does not exceed 15 inches.

WINTER PASTURES FOR THE SOUTH.

It is estimated that during the past winter one-third of the range stock of some of the ranges in Florida perished for lack of proper

nourishment. The winter being severe, losses of range stock were common in all parts of the South. It has been demonstrated that a number of plants can be made to furnish satisfactory pasture throughout the winter months in the South. During the past year a large amount of information concerning these plants and their adaptability to different soils, and the cultural methods required for their successful growth, has been collected. During the present season it is planned to cooperate with Southern experiment stations and Southern farmers in testing a number of these plants for winter pasture purposes.

GULF COAST CROPS.

The agrostologists of the Bureau are studying the forage value of the velvet bean, beggar weed, Mexican clover, and cassava for the region adjacent to the Gulf of Mexico, to which our standard forage crops are not adapted. They have shown that a well-nigh perfect stand of cassava can be obtained by germinating the canes in a cold frame or hotbed before planting them in the field. Heretofore the methods used produced ordinarily not more than half a stand of this crop. Methods of keeping cassava canes over winter are still being investigated. These investigations indicate that the most important factor in keeping the canes is maturity. It is extremely difficult to prevent decay of partially matured canes during the winter months. Forty-two varieties of cassava have been secured, one of which last year produced seed in southern Mississippi, although planted nearly two months later than the best planting season. This year one plant was grown from this seed. It seems probable that some of these varieties may be made to thrive considerably farther north than cassava has yet been grown.

FORAGE CROPS FOR SOUTHERN FLORIDA.

The development of truck farming in southern Florida has rendered urgent the need of forage crops for the work-stock used on the truck farms and for the dairy cattle which supply milk to the numerous hotels. Feed for this stock is now shipped long distances at great expense. It appears that Guinea grass and Para grass are adapted to climatic and soil conditions in that section and their possibilities for this purpose are being investigated. Guinea grass seems to possess particular value for hay production, while Para grass appears to be promising as a pasture grass, particularly for wet muck soils. The Bureau is preparing to give them an extended trial.

PACIFIC COAST PROBLEMS.

The office of Grass and Forage Plant Investigations is searching for forage crops to grow in alternation with wheat in order that farmers in the great wheat regions on the Pacific coast may be enabled to secure more than one crop every other year on their fertile lands. A number of grasses are also being studied with reference to their adaptability to dry lands in that section, where there are many thousands of acres of land too dry for any of the standard forage crops.

JOHNSON GRASS.

The agrostologists of the Bureau have demonstrated that the formidable pest known as Johnson grass may be completely destroyed

by practicable means and that it may easily be held in check. They are now making demonstrations of the methods developed in their investigations and are endeavoring to devise an implement for removing Johnson grass rootstocks from the soil.

SOILING CROPS.

With the development of stock farming and more intensive methods, particularly in the eastern half of the United States, the practice of soiling is becoming more important. Farm practice with reference to soiling crops is being studied with a view to formulating systems for all sections of the country. In this, as in all investigations, the experience of successful farmers has been of great assistance.

CROPS FOR OVERFLOWED LANDS.

The problem of utilizing lands subject to annual overflow has continued to receive attention. Particular attention has been given to short-season annual crops, such as millet, early varieties of corn and sorghum, buckwheat, cowpeas, soy beans, and rape, for lands that are free from water during midsummer and the fall season, and all these crops have been grown successfully on land that was covered with water until the latter part of June. The native grasses which are extensively cut for hay on overflowed and swamp lands are also being studied with a view to making seed of some of the best of them available on the markets, so that farmers who are in need of such grasses may be able to obtain their seed.

FRUIT-MARKETING INVESTIGATIONS.

Next in importance to ability to produce choice fruits is the existence of a sufficient demand for them at prices that will yield a fair profit to the grower. In fact, without reasonable assurance of market demand for the product at fair prices, the planting or maintenance of commercial orchards or vineyards is folly. From the nature of their product, which is at the same time perishable and an article of luxury rather than of absolute necessity to the average consumer, the prosperity of our fruit growers is more dependent upon the price of their product at the time of harvest than that of almost any other agricultural class. Glutted markets at such times are peculiarly disastrous both to individual fruit growers and to the regions in which commercial fruit culture has become an important feature of agriculture.

The avoidance of gluts is, therefore, of very great importance to the entire fruit industry. While many remedies have been suggested, that which appears most practicable and reasonable is the wider distribution of the product. For this reason the chief line of investigation in fruit marketing has been the determination of methods best adapted to the harvesting, packing, storing, and forwarding of fruits to points relatively distant from their places of production, with a view to developing wider demand for them, both in the United States and foreign countries. Chief attention has been thus far given to problems connected with the development of the trans-Atlantic export trade, the most important work having been done with summer and winter apples, peaches, and pears.

While some important points are yet unsettled in connection with these fruits and require the continuation of experimental work upon them, some gratifying evidence of the practical value of this line of work appears worthy of notice. The determination of the methods of handling and packing necessary to insure safe delivery of eastern-grown Bartlett pears in European markets during the season of 1902–3 was followed in the fiscal year 1904 by large and profitable shipments of this fruit from Eastern orchards to British markets. While official statistics are not available, it is known through commercial channels that more than 75,000 packages of this variety were thus exported, while the total shipments of Eastern-grown summer and fall pears amounted to at least 165 carloads. While this is but a small proportion of the entire pear crop, its removal from the domestic market was undoubtedly an important factor in maintaining the fair prices that prevailed in our markets during that season, notwithstanding the large crop of that fruit.

Largely through the efforts of the Department, which pointed out the way through experimental shipments which demonstrated the practicability of direct shipments of winter apples to French markets, an encouraging beginning in commercial shipments has resulted. Commercial estimates indicate that during the fiscal year 1904 our direct exportation of apples to France amounted to 200 carloads, which is about twelve times as much as the annual average of the preceding five years. With systematic and judicious continuation of such shipments until consumers become accustomed to American varieties and methods of packing, the French market should rapidly become an important factor in our export apple trade.

The most important experimental export work has been done upon winter apples, as the magnitude of the apple industry warrants first attention. A series of shipments to the principal European markets, in an effort to determine the relative value of the barrel and the box as export packages for this fruit, has disclosed on the whole very little difference in the net results where ordinary "No. 1" fruit was shipped, either with or without paper wrapping. These results are not considered conclusive evidence of the quality of these packages, however, as it is known that in such matters repeated tests are required to insure correct interpretation of results. Increased work along this line will be done during the coming year.

While exact determination of the effect of these investigations on the development of export trade can not be ascertained, it is interesting to note that a comparison of commercial estimates of the crops of the successive seasons with the exports of the corresponding fiscal years shows a steady increase in the proportion of the crop exported, as well as a large increase in the quantity shipped, the proportion exported having risen from less than 1 per cent of the estimated total crop for 1899–1900 to nearly 4¾ per cent in 1903–4, with a total of 2,018,262 barrels, valued at $5,446,473, in the latter year.

PROGRESS IN FRUIT-STORAGE INVESTIGATIONS.

The cold storage of fruit has grown to large proportions in the last decade, nearly 3 million barrels being cold-stored in the United States last year. When the Bureau began investigations along this line three years ago there was little exact information about the fac-

tors which influenced the keeping of fruit. It was popularly supposed that a cold temperature was the most important consideration in successful fruit storage, and that the frequent heavy losses were generally due to unfavorable storage conditions. As a result of the investigations, especially during the past year, it has been demonstrated that the condition in which the fruit is grown and the manner of handling it determine to a large extent the keeping quality as well as the ultimate value of the fruit. Fruit grown to unusual size, like that from rapidly growing young trees, from trees producing a light crop, or from trees forced unduly by tillage or by other orchard treatment, has been shown to deteriorate from one to three months earlier than the same variety grown more slowly.

The investigations are showing that fruit intended for storage must be handled with the utmost care in picking, packing, and shipping, and stored quickly after picking in well-ventilated rooms in a temperature of about 31° to 32° F., if the storage difficulties now most common are to be overcome.

During the past season the Bureau has undertaken to determine what factors cause the frequent losses that occur in shipping perishable fruits, such as peaches, to distant markets. From 5 to 30 per cent of decayed and soft peaches in the top layers of a refrigerator car on arrival at destination from the Southern peach areas is not uncommon, especially in moist, warm weather. Several cars in which the fruit was cooled quickly after picking to about 40° F. were shipped from Georgia to Northern markets. All of this fruit arrived in practically perfect condition, demonstrating that the common practice of loading perishable fruits in a heated condition is one of the important factors in causing serious economic losses. Furthermore, it was demonstrated that the cars could be loaded more heavily with little danger of the fruit in the top of the car deteriorating, and the fruit was harvested and reached the consumer in a riper and better condition on account of the better carrying quality.

In addition to the work outlined, the Bureau is endeavoring to supply the demand for information from fruit growers by determining what cold-storage systems are best adapted to farm use.

There has been a demand for experimental work in fruit marketing and storage from fruit growers on the Pacific coast. The funds available have limited the work to the East up to this time. During the present winter the investigations will be extended to the citrus industry of California, which in the season of 1903–4 amounted to 30,000 carloads of oranges and lemons. The losses in transit and in warehouses when the warm spring weather sets in are sometimes very large. It is proposed to find out what relation the present methods of picking, packing, handling, and shipping the fruit bear to these losses, in a manner similar to the investigations with deciduous fruits.

That these investigations in fruit storage are having an important influence in improving the commercial methods of handling our fruit products is seen in their growing application by fruit growers, handlers, and warehousemen, all of whom are making demands on the Department for information and for enlarged investigations.

NEW PLANT CREATIONS.

The plant-breeding work, heretofore described, has been continued along a number of new lines. Great advances have been made in the

matter of securing new and desirable long-staple cottons. During the last three years a number of long-staple Upland varieties of cotton have been originated, and these have come to be cultivated to some extent in certain parts of the cotton belt, and very generally in the rich bottom lands of the Mississippi and Red rivers in Mississippi, Arkansas, Louisiana, and Texas. A large number of hybrids have been made for the purpose of securing Upland types of long-staple cottons, which can be put into general cultivation, and which will be superior to those now in use. Several of these hybrids are approaching fixity of type. Among these are some having a staple from 1¼ to 1⅝ inches in length.

In the breeding and improvement of corn important advances are being made. The main object of this work has been the selection of strains of corn best adapted to the different sections of the United States. The work is being conducted in cooperation with twenty or more State experiment stations and many farmers. Each year the Department obtains pure seed from the originators and breeders of the leading strains of corn in various sections of the country, and is sending this seed to different localties for comparative tests. At the same time extensive hybridization work is proceeding for the purpose of securing sweeter, more tender, and more productive strains of sweet corn for table use. Connected with this work, also, there are being studied problems relating to the handling of seed corn, seed selection, etc.

Extensive breeding investigations of oats have been carried on, mainly for the purpose of producing a profitable variety for the rich farm lands of the great corn-growing States, where oats are used in rotation with corn. The production of a more desirable oat for meal constitutes a part of this work. Some very promising hybrids have been obtained from the naked oat of China—the so-called "European hull-less oat."

In the improvement of potatoes important work has been conducted along two lines—(1) type selections, and (2) the production of new seedling varieties. This work was begun in 1902, and already very promising results have been obtained, especially from some of the hybrids.

Some of the most important investigations in the matter of breeding and selection have been inaugurated in connection with the growing of tobacco. This work is conducted along two principal lines—(1) the selection of individual types in the varieties, and (2) crosses between different varieties. Extensive work has been carried on in Connecticut, where both shade and outside tobacco are grown. The work conducted so far has shown unquestionably that the desirable characteristics in the leaf can be fixed from the first year's selection. In this work nine different types have been used and more than 300 selections have been made of each type. One hundred and twenty-five plants are used as a standard for each selection. Thus the work of selection alone has involved the use of something over 40,000 plants.

The work has been conducted in such a way that all the plants have been grown under tent shade, and the entire development of the leaf, from the seed bed to the manufactured product, can be followed. Allied with this work extensive investigations have been made as to the effect of hybridization. Hybrids are easily secured, and from the evidence already obtained by experience in the Connecticut Valley it is believed that the improvement of tobacco by crossing is practica-

ble and can be successfully carried out according to plans now in operation.

Other important lines of work, having for their object the securing of new types of grains, fruits, and other crops, have been carried on. Important work has been done in the matter of developing new varieties of pineapples, new varieties of pears, and other fruits.

PROGRESS IN SEED AND PLANT INTRODUCTION.

The work of introducing and establishing new plants from foreign countries has resulted during the year in the introduction of 1,429 selected kinds of seeds and plants. These have been secured through correspondence and by means of our agricultural explorers, one of whom was sent to the Russian Caucasus in search of new varieties of fruits; one to the West Indies for tropical cassava; a third made an extensive study of the European flax regions, and a fourth visited Mexico in search of southern country apricots. Such a large number of plants, introduced during previous years, remained to be adjusted to American conditions that the efforts this year, more than last, were concentrated on the domestic side of the problems, and no very extensive exploring trips were undertaken. Notwithstanding this, however, a number of new important importations were made. A shipment of over 350 date suckers, representing 42 varieties, mostly new to America, was made from the oasis of Biskra in the Sahara. Two hundred and seventy samples of different strains of European flax were collected. A collection of 19 selected varieties of grapes from the Russian Caucasus was arranged for. Two hundred and fifty pounds of seeds of the true pistache and smaller quantities of seeds of related species for stocks were imported from Turkey and Central Asia. Thirty-three varieties of mangoes of recognized superiority were secured from Central India in Wardian cases for Florida cultivators.

A shipment of 157 bushels of berseem was made from the valley of the Nile. Two thousand pounds of the famous pedigreed Hanna barley were secured from its originator in Moravia. Two hundred trees of the hardy Vladimir cherry, for trial in the Northwest, were imported from Russia. One hundred and five varieties of French phylloxera-resistant grapevines were secured for trial in infested California vineyards. New species of the lily, from the Philippines and the Neilgherry hills of India, were introduced for breeding purposes. The yang-taw, from Central China, an entirely new fruit-producing vine, was presented to the Department by Consul Wilcox, of Hankow. A number of promising resistant South African grapevines, a collection of Canary Island plants, some East African sorghums, and an interesting clover from Uganda were some of the gifts of Mr. Barbour Lathrop, whose expeditions in search of plants for this Department have been mentioned in previous reports.

Many of the important introductions from previous years still occupy the attention of the office, and either require fresh material from abroad or necessitate field experiments. The durum wheat area has been greatly extended, as already noted. A new date garden in the desert region of southern California has been established in cooperation with the State experiment station. The Egyptian cotton introductions are leading to the production of new hybrid races of

promise. The Malin or Moravian horse-radish has proved a success. Japanese bamboo and Mitsumata paper plantations are being arranged for. Tropical mangosteens, imported by post, are being successfully propagated for distribution in Porto Rico and Hawaii. Egyptian clover is being given an extensive trial in Texas, Louisiana, and California. A new seedless pomelo from Siam has been grown for distribution. The Turkestan alfalfa has seeded in several localities, and the securing of American-grown seed of this variety is now a possibility.

CONGRESSIONAL SEED DISTRIBUTION.

As pointed out in my previous reports, constant efforts are being made toward the improvement of methods of securing and handling the general seeds for Congressional distribution. Improved appliances have been perfected for the mechanical work, and improved methods have been adopted for securing the seed. The work is now all under the direct supervision of efficient officers of the Bureau of Plant Industry. Every effort is being made to improve the quality of the seed by securing pure stocks. Extensive work is being conducted in the matter of a critical study of varieties under different conditions of soil and climate. Testing gardens for this purpose have been established in a number of localities, and the work is under the supervision of a thoroughly competent expert horticulturist. Every effort is being made to encourage home seed growing. Practically all of the vegetable seed now distributed by the Department is grown in the United States.

A few years ago nearly all of the flower seed, except sweet peas, was imported. Now fully 75 per cent is grown here, through the encouragement offered by the Department in this work. A special effort is put forth in the matter of distributing promising varieties of cotton, tobacco, forage crop, and other seeds. The cotton experts of the Bureau have been constantly at work securing new and desirable sorts wherever they have been found in connection with the other cotton investigations. The results of this continuous distribution of improved strains are already beginning to show in a number of sections of the South.

In the handling of this enormous work which Congress puts upon the Department, the necessity for strict business methods has been fully observed. The work of handling one branch only of this problem involves the securing of more than 25 carloads of special seed, and the testing, packeting, and mailing of this large quantity to all parts of the United States. The systematizing of all the operations has been so perfected that there is little or no friction at the present time.

NITROGEN-FIXING BACTERIA.

Extensive practical tests were made the past season with nitrogen-fixing bacteria for use in connection with leguminous crops. The results have been even more successful than we had anticipated. Hundreds of applications have been sent in from every State in the Union for material with which to inoculate various crops. Practically all of these requests have been complied with in such a way that a record of the results could be obtained. The results show conclusively that where the organisms are used in accordance with the directions issued

by the Bureau increased yields, ranging from 15 to 35 per cent, are secured. Furthermore, many farmers have been successful in getting stands of clovers and other crops on soils where failure has resulted heretofore. The several strains of bacteria sent out from the Department have proved valuable even on soils containing the uncultivated organisms in abundance. It was discovered during the year that tubercle formation is not necessary to successful inoculation.

The bacteria can be present in the roots of legumes in a very efficient state with no tubercle formation whatever. The material for inoculating an acre of soil by the methods which have been developed costs the Department about 1 cent per acre and the farmer scarcely anything to apply it. So great has become the demand for this material that private concerns have become convinced that there is profit in preparing and distributing it, and several firms are now announcing their preparedness for doing this. Widespread interest in the subject has been manifested by the agricultural press and the magazines, and as a result of this propaganda work the demand for the organisms is constantly increasing.

INVESTIGATION OF PLANTS POISONOUS TO STOCK.

In parts of the Northwest where sheep grazing is an extensive industry, very great losses have been experienced in many sections, due to the so-called "loco disease." This disease is commonly attributed to the eating of the loco weed, by which parts of the range are almost monopolized. In one county in one of the Northwestern States in which sheep grazing has been the chief industry, the disease has made such inroads that many stockmen have been obliged to give up sheep grazing altogether, with the result that land values have depreciated and the sheep from this region are viewed with suspicion by buyers.

During the past two years investigations have been made to test the relation between this devastating trouble and the so-called "loco weed" prevalent in this section of the country.

FIBER PLANTS.

The textile industries using plant fibers have been growing, with lcineased demand for twine, cordage, and woven goods, but, with the exception of cotton, the production of plant fibers in this country has not kept pace with the consumption. The raw fiber imported during the fiscal year ended June 30, 1904, was valued at more than $47,000,000. This amount included about $9,000,000 worth of cotton, chiefly Egyptian and other grades, not produced here commercially. The other fibers imported were mostly sisal, manila, jute, flax, istle, and hemp. Investigations of all these fibers have been conducted by the Bureau, special attention being given to those likely to succeed in our own country.

DRY-LAND AGRICULTURE.

In my last annual report attention was called to the importance of developing a system of agriculture adapted to the semiarid areas of the United States where general irrigation for ordinary crops is not practicable or possible owing to the small annual rainfall and the consequent lack of sufficient water. This is true of nearly one-fourth of

the entire arable land surface of this country. It is believed, however, that a profitable system of agriculture can be developed for these areas by securing crops which will grow with a very small amount of water. Considerable progress has been made in this direction and facts have been secured which show the necessity of an immediate and thorough investigation of the conditions affecting the moisture requirements of crop plants for growth in semiarid regions, such as Kafir corn, alfalfa, drought-resistant wheats, and other crops at present unknown to American agriculture.

WATER PURIFICATION INVESTIGATIONS.

Attention was called in my last report to the investigations being carried on by the physiologists of the Bureau of Plant Industry with a view to finding methods of destroying obnoxious algæ in water supplies. The method discovered consists in using extremely dilute solutions of copper sulphate. After a chemical and microscopical study of the water to be treated, and identification of the contaminating organisms, the amount of copper required to be effective is determined and introduced in the form of sulphate. Numerous tests have been made in cooperation with boards of health and water engineers in a number of large reservoirs, and the method has proved remarkably efficient and successful. The fact that one part of copper sulphate to one hundred thousand parts of water will at ordinary temperatures completely destroy the bacteria causing typhoid fever and Asiatic cholera suggests the great usefulness of copper in fighting these diseases and other maladies caused by closely related organisms. Physicians and public health officials have taken great interest in this work, and will doubtless make prompt and thorough tests of the usefulness of copper in such cases.

CONSTRUCTION OF NEW GREENHOUSES.

The new buildings planned for the Department made it necessary to remove the glass houses now on the grounds. A special appropriation of $25,000 was secured for this purpose, and the new houses have been erected and are now complete. This new range consists of 8 modern houses, each 142 feet long, which were put up under contract. Three additional houses have been put up by the Bureau's force of workers, and two of the smaller houses have been moved from their old location to the new one. The new range is much more satisfactory than the old one, and it will be devoted to various lines of work connected with the Bureau. The contract for the new houses was let on June 1, 1904, and they were completed on September 1 of the same year.

ARLINGTON FARM.

During the year the important work of improving the soil conditions at the Arlington Farm has been continued. New systems of drainage have been put in, cottages for the superintendent and other workers constructed, barns erected, and other improvements made; and the farm has been put in shape for the advanced experimental work it is proposed to conduct there. Extensive plantings have also been made of economic fruits, ornamental trees, and other plants.

Test work with potatoes, celery, forage crops, and various fruits has been carried on. Cooperative work with other bureaus has also been inaugurated.

COOPERATION WITH STATE EXPERIMENT STATIONS.

The Bureau of Plant Industry is now cooperating with practically all of the State experiment stations in the country. The work covers investigations of diseases of plants, studies having for their object plant improvement, investigation of forage crop conditions, encouragement in the production of new crops and new industries, and many other lines of work. In some special cases, notably California, close cooperation has been effected, having for its object the establishment of important testing gardens and other allied work. With the assistance of the officers of the California experiment station a testing garden has been established at Chico, Cal. The land for this garden has been donated to the experiment station, to be held in trust by the station for the use of the Bureau.

It is planned to carry on extensive work here in the matter of testing grains, fruits, and other crops specially adapted to the Pacific Coast. It is the policy of the Department in all cooperative work with the stations to fully recognize the relations of the stations to the officers who control them. Furthermore, wherever the Department desires to undertake work in a State, its policy is to endeavor to do this work in cooperation with the station.

FARM MANAGEMENT.

In order to properly conduct the work on farm management, which has already been set forth in previous reports, an office has been established for the purpose. The object of this office is to bring together in systematic shape all of the available information in the Bureau in such a way that it can be placed in the hands of the farmer for his practical use. The office gathers together information concerning farm practice in all sections of the country as a basis for further work. It secures and publishes correct records of crops grown and the manner of growing them, for the information of others who desire to follow successful plans. It encourages farmers to visit and study experiment station work, the experiment stations, and the successful farmers in their own section. It encourages diversification in farming where continuous, clean cultivation of a single crop has impoverished the soil. It outlines systems of cropping for different kinds of farming in all sections of the country, and furnishes data in the matter of properly laying out farms, fruit plantations, truck gardens, etc.

BUREAU OF FORESTRY.

PRESENT FOREST SITUATION IN THE UNITED STATES.

The present outlook as regards forestry in the United States is exceedingly hopeful. The lumber industry as a whole is now awakening to the fact that lumbering with reference to future as well as present profits may be good business and ought to be taken into account on business grounds. A growing tendency to hold cut-over

lands is plainly marked among far-sighted owners of large holdings. This means that conservative management on the part of those who operate on a large scale is fairly launched. Except that further agitation is essential to give the facts publicity, the general adoption of forestry as an established policy now depends primarily on business conditions pure and simple. The question whether or not it will pay is one to be settled in each individual case by study of conditions on the ground. Forestry can not alter economic conditions; it can only use them. Forestry is now in actual practice on large, privately owned tracts in seven different States. This is the direct result of the past work of this Department in forestry.

FIELDS FOR FUTURE WORK OF THE BUREAU.

NEED OF INVESTIGATING GENERAL FOREST PROBLEMS.

Extensive investigations of forest conditions and of methods of operation are still urgently needed before the road to practical success can be said to be generally open. The employment of foresters by large private owners to supervise operations on their own lands is being taken up. In the public interest this needs to be brought about wherever conditions are favorable, but more and more the promotion of private forestry by the Bureau of Forestry can and should be made incidental to its other functions of directing the management of public forest lands and scientifically investigating general forest problems.

In the case of small owners much remains to be done. The farmers of the country are learning how to get the most out of their land in other ways through the scientific information which the Department of Agriculture collects and diffuses. So, also, in the case of timber yield, studies which individuals can not undertake but which must be made if the wealth-producing power of the country as a whole is to be brought to its highest point, need to be prosecuted in the public interest. The average small timber-land owner is to-day in many parts of the country a a decided disadvantage in comparison with the large owner, because he lacks both working capital and equally broad knowledge of general conditions. It is true that large lumbering operations can often be made more profitable than small, but it is not in the public interest that small owners should fail to make a profit which is within their reach because they do not know how best to utilize what they have now, or do not realize what it is likely to be worth in the future. Thus the furtherance of that part of this Department's work which is directed toward informing the small owner how he can to advantage practice forestry on his own account, is of the first importance for the best use of the 200 million acres of woodlots which our country contains.

SCIENTIFIC STUDIES AND AID IN CARE OF STATE AND NATIONAL FORESTS.

By its scientific studies of American forests the Bureau of Forestry has prepared a solid basis for practical forestry. Special studies of our important timber trees have yielded information obtainable in no other way and essential to the management of forests of which they form an important part. There is now no considerable portion of the United States for which the Bureau of Forestry has not at hand special

knowledge bearing directly on questions pertaining to the use of the forests. Nevertheless, what has been done is hardly a beginning in comparison with the vastness of the field.

In the work of building up a sound permanent policy for the forests of the National domain the Department of Agriculture has continued to render important services. Much of the work of the Bureau of Forestry during the year has been the examination of lands already reserved or likely to be reserved in order to recommend the exclusion from them of such areas as are more valuable for agriculture than under forest. The personnel of the Bureau of Forestry has become practically familiar, by studies on the ground, with every phase of the question of putting to the best use the public lands of the country. Thus an efficient force has been prepared by actual experience, as well as by technical, scientific training, for the demands which a fully developed National forest policy must eventually impose.

In the light of these facts it is plain that the ultimate function of the Bureau of Forestry as a part of the Government administrative equipment is gradually defining itself. Its effort to introduce forest management among large private owners at the earliest possible moment will cease to be necessary when it becomes generally successful. It was undertaken because of an evident urgent public need. Destructive lumbering had already greatly reduced the area of productive timber lands in the United States, and its continuance was a menace to the future prosperity of the country. Because of the work of this Bureau forestry has now a recognized standing in the eyes of the American lumber trade. The Bureau of Forestry is giving a smaller proportion of its time to the preparation of working plans for large timber tracts belonging to private owners than ever before, and bearing a smaller proportion of the expense, and the progress of the past year has brought visibly nearer the time when it can withdraw practically or entirely from this field.

There will then chiefly remain work along the lines of (1) scientific study of problems which have a practical bearing on forest utilization for any purpose; (2) cooperation with States which ask advice concerning forest legislation, administration, or the formulation of a State forest policy, and (3) the discharge of whatever duties may be assigned to it in connection with the administration of the public lands by the National Government.

Along this latter line it is at present the official adviser in technical matters of the Departments which have in charge forested lands under Government control, both here and in the Philippines, and it is also chiefly responsible for recommending changes in present reserve boundaries and for recommending the setting aside of new reserves. The policy which lies at the base of the creation of the reserves is that the public forests should not be withdrawn from use, but should be managed under such restrictions as will insure their permanent usefulness. This policy this Department is actively furthering, and no part of its work is more important.

LINES OF WORK REQUIRING EXTENSION.

An increase in the funds available for the Bureau of Forestry is essential to make it possible to push its work more rapidly. It is my purpose to provide the fullest facilities for the prompt investigation

of actual or proposed forest reserves, as well as for further examinations of forested parts of the public domain not now reserved which give promise of permanent value as sources of water or wood supply. The greatest need of the West is water. In many States future settlement and prosperity depend absolutely upon its conservation. This again largely, in many cases wholly, depends on the preservation of the forests. To make possible the execution and extension of the work, I have asked for an increased appropriation for the Bureau of Forestry for the coming year.

PLANTING ON FOREST RESERVES.—The work of planting on forest reserves opens another fruitful field. In the San Gabriel Reserve in California, the Pikes Peak Reserve in Colorado, and the Dismal River Reserve in Nebraska, the planting has been begun and should be vigorously prosecuted. In the first two cases the object is to cover denuded mountain slopes with forest growth, in the interest primarily of water conservation and, in the case of the Nebraska reserve, to provide a future valuable timber supply. This planting is undertaken only after a careful preliminary survey has proved that there is an economic need for new growth which nature can not supply, and after painstaking experiment has demonstrated what methods can be depended on for success. Under these circumstances expenditure for planting is as truly economical as is that of the farmer when he purchases seed to sow that he may harvest the increase. I believe that an addition to the sum available for this work will be amply justified by the returns.

The development of economic mining will soon wait for the growth of trees within reasonable distance. The miner is an important factor in the growth of many of our States and of the country at large, and should have all facilities given him to conduct his work on the most economic basis. Where the miner ceases work the farm and factory lose a market. For this reason the miner should have the first claim on the forest for such timbers as he requires.

STUDIES IN FOREST PRODUCTS.—Auxiliary to studies of the forest itself, but of the most importance in relation to the conservative use of our forest resources, stand the studies in forest products. Among them at the present time are (1) the studies in timber preservation, especially of railroad ties, which promise such conspicuous and successful results in timber economy; (2) the experiments in timber testing, to ascertain, under such conditions as obtain in actual everyday practice, new strength determinations for use by engineers, architects, and others; and (3) the investigations of the tannin content of barks, of pulp processes, etc. In the way of securing large economies by a comparatively small outlay for investigation, no more promising field for useful work by the Bureau of Forestry is open than this.

COOPERATION WITH STATE AUTHORITIES.—The desire of State authorities for the assistance of the Bureau of Forestry in cooperative work and in framing forest legislation and their willingness to contribute to its cost are facts worth noting. State cooperative studies have now been made in Maine, New Hampshire, New York, Maryland, Michigan, Wisconsin, California, and Hawaii. Were this Department prepared to push the work along this line large results could be rapidly secured. The whole cause of forest preservation hinges on the interest of the State governments, because no matter how fully persuaded the private owner may be that forest management promises

o yield him good returns, without fair assurance of safeguard against re and of equitable taxation during the period required for a second rop to mature on cut-over lands, he can make no headway. The xclusion of fire depends on local sentiment, State legislation, and tate or local police and patrol. Unless the States are awake to their uty toward this form of property the Federal Government can do ittle beyond caring for its own holdings. In California one result of he cooperative work now going on is the drafting of what appears to e the best forest-fire law yet drawn up in this country. The way is ow open for a great advance through State cooperation if the requiite means of meeting its cost beyond the State contributions can be nade available.

SUCCESS OF FORESTRY WORK.

The successive advances which have been made by Congress of ecent years in the appropriation for the Bureau of Forestry offer one f the best evidences of the commendation which its work has received. More and more money has been given to it to spend because it has roved year by year its capacity to do more, and more practical, good work. It prosecutes its researches solely that it may discover and liffuse information which contributes to our National well-being. Within six years its force has increased sixteenfold and its expendiure twelvefold; but neither of these facts is an adequate measure of ts advance in practical efficiency or of its success in changing former conditions. By a single discovery—that the cup and gutter system, levised by one of its agents, could be commercially applied to the production of crude turpentine—it is now saving many times more annually to the naval-stores industry than the total expenditures of the Bureau during the whole six years.

It has changed forestry for business returns in the United States from an undemonstrated and doubtful theory into a well-established business operation; it has converted the lumber industry of the country from an attitude of well-grounded suspicion to one of support; it has converted the general public from indifference to what seemed an impractical outcry to an intelligent comprehension of what forestry has to offer. By bringing home to the railroads the need of economic utilization, preservative treatment, and provision for future supplies it has set on foot a movement of incalculable importance. By teaching Western farmers how to plant and grow trees for farm protection and local timber supplies it has added materially to the comfort and prosperity of vast regions and many States. More important still, by demonstrating the capacity of the forest to store water, and by energetic activity to guard from sale or destruction forests of important protective power, it has contributed to the success of National irrigation, one of the most vital developments of recent years.

But though this Bureau has accomplished and is accomplishing practical results out of all proportion to its money expenditure, this is not exceptional in the Department of Agriculture, and forms in itself no justification for a further increase. The question is simply in each case whether the country will be better off by spending the money or by not spending it. There are, however, certain special reasons why the Bureau of Forestry should have made, and should for some time continue to make, an exceptionally rapid growth. Its task is virtually that of building up a new science in this country, combined with that

of getting its discoveries recognized and applied by a public once little alive to their value. No other branch of agricultural science has recently been in such need of development, and in the whole history of agricultural progress I believe that no other similar development was ever more timely. This development took place because of the unparalleled National need created by the vastness of the interest involved and the critical point which forest destruction had reached. And there is still much to be done before this new science can overtake the nation's requirements.

WORK ACCOMPLISHED DURING THE YEAR.

COOPERATIVE STATE FOREST STUDIES.

Forest studies in cooperation with State or Territorial governments were carried on during the year in New Hampshire, Maryland, Wisconsin, California, and Hawaii. A report on the work in New Hampshire is now in the hands of the printer. It contains a thorough study of the main forest resources of the State, and will afford a satisfactory basis for the adoption of a broad and far-sighted State forest policy.

The study in Hawaii resulted in the publication of a bulletin on "The Forests of the Hawaiian Islands," in the adoption by the Territorial government of its recommendations, and the appointment of a member of the Bureau of Forestry as superintendent of forestry in the islands.

A map and report embodying results of the work in Maryland will appear in the annual report of the State geologist.

In California over 20,000,000 acres of forest were mapped and described; the growth of planted eucalypts was studied; important investigations of the effects of chaparral cover on water conservation and on the forest, and of the forest replacement on denuded areas, were prosecuted; and the study of forest fires was continued, with the result that what is believed to be the best fire law ever prepared for State enactment has been drafted for presentation to the legislature.

FOREST MEASUREMENTS.

Of forest measurements there were handled during the last fiscal year the results of over 24,000 acres of valuation surveys, over 33,000 analyses of trees, 16,000 height measurements, and 2,300 taper measurements. The volume of this work does not, however, measure its importance. In computing, compiling, and digesting the mass of information supplied by the field studies of the Bureau the accumulation of details would count for little if the results were worked up by purely routine or mechanical methods. The task imposed is to create a body of scientific knowledge by developing to significant conclusions the raw material turned in—a task calling first of all for intelligence and insight. The result is real advance in accurate knowledge of forest conditions and increasing ability to direct practical operations. Both in the preparation of working plans and in the special studies of commercial trees and forest problems which have been made during the year the efficiency of the work included under forest measurements has been demonstrated.

FOREST MANAGEMENT.

The work of the Bureau under the act of Congress of June 27, 1902, known as the Morris bill, has proved that conservative lumbering under practical regulations pays in the white-pine region of northern Minnesota. In point of fact a higher price was obtained for the timber sold under that act, to be cut and removed under rules prescribed by the Forester, than similar adjacent timber brought shortly before, when sold without such restrictions. On about one-fourth of the 200,000 acres to be lumbered the 5 per cent of timber to be left standing had been selected and marked at the end of the fiscal year.

During the year applications for assistance in introducing forest management on private holdings were received from 47 owners of large tracts, covering nearly 4,000,000 acres, and from 89 owners of woodlots with a total area of about 6,600 acres. The field work for eight working plans for large tracts, covering about 1,000,000 acres, was completed, and for 68 woodlots of nearly 19,000 acres total area.

The eight working plans for large tracts were studies of typical problems in five widely separated States. In Minnesota a tract of land formerly covered mainly with white and Norway pine, a large part of which has been lumbered and is now entirely unproductive, presented a characteristic example of much of the remaining forest land of the lake region. The plan of management devised provides for reproduction from seed trees and for fire protection. In Alabama a working plan was prepared for two forests of virgin longleaf pine, owned by one company, which wished to be assured of a continuous mill supply. In Texas another longleaf-pine study completed during the year furnished the material for estimating present and future yields of longleaf and at the same time demonstrated the wastefulness of some of the lumbering methods now commonly followed.

In West Virginia a tract covered with hardwood, hemlock, and spruce forest, much of which is in poor condition, was studied to ascertain the practicability of management. In New Hampshire three working plans were prepared: one for a tract where the requirement was primarily the improvement of a forest-park property; the second for the tract of a manufacturing company wishing to secure a steady supply of box boards and increase the productiveness of the forest; and the third for a White Mountain tract, where the chief requirement was a system of fire protection.

Commercial tree studies of the year included balsam fir, paper birch, poplar, loblolly pine, and red gum.

DENDROLOGY.

Reports which mark the conclusion of the field studies of Missouri swamp forests and Ohio hardwood forests, and of the laboratory studies of gums, resins, tan barks, and pulp-wood fibers conducted in cooperation with the Bureau of Chemistry, were completed during the year. Field work was completed in the studies of California big trees and bristlecone fir, and of turpentine orcharding and laboratory work in a cooperative investigation of turpentine adulterants. A descriptive study of the forests of Suffolk and Nassau counties, Long Island, was begun and finished; investigations of Pacific coast tan-bark trees and of basket-willow culture were continued; and an investigation of

methods of turpentine distillation, with special reference to improving commercial processes of production in this country, was begun. Experiments bearing on the culture of the sugar maple were made to supplement a study of the sugar-maple industry previously completed. The collection of forest photographs received notable additions by exchange with foreign countries, and by gifts as well as by the normal increase from the new photographs obtained by the Bureau of Forestry in connection with its field work.

FOREST EXTENSION.

In the work of cooperation with private owners to promote forest planting the Bureau of Forestry prepared during the year 42 planting plans for an aggregate of over 2,800 acres. Altogether 334 planting plans have been made for land in 52 States and Territories. This is a work of high utility, particularly in those regions of the West where timber and water are scarce and farm protection against hot or cold winds is important. Cooperation is confined to the giving of expert advice; all the expense of the planting is borne by the owner. By the adoption of a system of regional studies rapid progress is being made toward a point at which this expert advice can ordinarily be given by correspondence. When this point is reached, the Bureau of Forestry will be in a position to contribute materially to the well-being of wide regions at almost no expense.

In forest-reserve planting extensive operations are now under way in Nebraska, where previous experiments have pointed out how planting on a large scale can be made successful. In the spring of 1904 there were taken from the nursery and planted in the Dismal River Reserve 300,000 seedlings, of which over 90 per cent survived. Highly efficient and economical methods of doing this work were devised. Preliminary preparations for planting were made in the Niobrara Reserve, Nebraska, the San Gabriel Reserve, California, and the Pikes Peak Reserve, Colorado.

Studies of natural forest replacement were conducted in Colorado, western Kansas, western Nebraska, northern New Mexico, and New England.

The investigation of forest fires, with especial reference to methods of preventing and controlling them, has been continued, and encouraging progress made. The study of the reclamation of shifting sand through forest growth was continued.

FOREST PRODUCTS.

The studies in timber preservation conducted by the Bureau of Forestry are yielding results of large economic importance. Extensive experiments were conducted during the year in the West with longleaf, shortleaf, loblolly, lodgepole, and western yellow pine, spruce, and white and red fir ties. Ties were employed for these tests partly because of the opportunities for experiments of general application afforded by the selection of this form of timber, and partly because of the intrinsic importance of the specific subject of tie preservation. These experiments have already developed a number of important facts connected with timber seasoning and preservation.

In the Central States similar experiments were made with a large number of hardwood timbers, especially with those possibly capable of

filling the place for certain uses of white oak and hickory, the supply of which is dwindling fast. It was found that chemical treatment will permit their use for structural purposes; that conspicuous improvement in present methods of seasoning is possible; and that the effectiveness of preservative treatment of red oak is greatly increased by thorough seasoning both before and after treatment.

In the East the seasoning of and application of preservatives to telegraph and telephone poles and cross arms were investigated, and discoveries which render possible considerable economies were made. Further experiments to reduce the rate of decay of poles at the butt are under way. Seasoning experiments are in progress with Adirondack hardwoods.

The investigation of the strength of timbers directly meets the needs of engineers, architects, and others who have to do with the use of construction timber, and is likely to be followed by a revision of specification requirements and grading rules. Large timbers in market forms and sizes, of red fir, western hemlock, and loblolly and longleaf pine were tested. Eastern investigations of many species are needed in the interest of the most economical use of our timber supply; for it is undoubtedly true that timber trees neglected hitherto will be found to possess unsuspected value.

Other important lines of investigation pursued were a study of the mechanical properties of red gum, which established, among other things, its suitability for carriage manufacture; studies of the relative strength of various forms of tie fastenings and of devices to prevent the rapid wear of soft timbers protected against decay by preservative treatment; and a study of the effect of moisture content on the strength of timber.

LOUISIANA PURCHASE EXPOSITION FOREST EXHIBIT.

The most extensive and complete forest exhibit ever made by this Bureau was installed at the Exposition at St. Louis. It included the execution out of doors of tree-planting plans and the setting of trees adapted to every part of the country, and an exhibit of the best forest nursery methods. A full exhibit by transparencies, pictures, and apparatus illustrated every phase of our forestry work and forest conditions in all parts of the country. Methods of testing commercial timber were illustrated, and an experimental plant for wood preservation was established and operated during the Fair.

BUREAU OF CHEMISTRY.

The Bureau of Chemistry, during the last few years, has expanded the sphere of its activity in many directions.

AID TO OTHER DEPARTMENTS.

First to be noticed of this expansion is the work done under that authorization by Congress which secures the services of this Bureau for the other Departments of the Government. Under this authority the amount of work which has been done for the other Departments has rapidly increased. This is especially true of chemical determinations in collaboration with the Treasury Department.

For the Department of Justice extensive investigations have been undertaken to determine the injuries suffered by forest reserves from the fumes of smelters. For this Department, also, numerous chemical investigations have been made in connection with cases arising in the administration of justice in the Indian reservations and in certain cases of poisoning which have occurred within those reservations.

For the Post-Office Department extensive examinations have been made of canceling stamps and the inks used therewith; also of alleged remedies offered by advertisements through the mails and regarded by the postal authorities as fraudulent in their nature.

For the various Departments a large number of analyses have been made of articles offered under contract to determine whether these articles are of the quality and purity specified in the contracts.

FOOD INSPECTION.

The second important item in the expansion of the work of the Bureau of Chemistry has been the establishment of inspection for imported food products. Attention is invited to the fact that under this law the character of food products imported to this country has been greatly improved.

In former years the United States was regarded as the dumping ground for the refuse teas of the commerce of the world. Many years ago, in order to overcome this evil, a system of inspection of imported teas was established and has since been maintained. Under the beneficent working of this system Americans are now certain of being able to purchase pure and wholesome tea, since it is almost impossible for spurious and adulterated teas to find their way into this country. Congress has now extended this system of inspection to all foods, beverages, and condiments imported into the United States. There is every reason to believe that when this system is thoroughly established an improved condition comparable to that which has taken place in teas may be anticipated.

FOOD STANDARDS.

Another important advance which deserves special attention is that relating to standards of purity for food products. The Secretary of Agriculture has been authorized by Congress to fix standards, and in order that they may be just and reasonable he has been authorized to call to his assistance the experts of the Association of Official Agricultural Chemists and other experts, as he may see fit, to advise him in regard to such matters. The work of ascertaining these proper standards, in collaboration with the Association of Official Agricultural Chemists, has been committed to the Bureau of Chemistry. Already considerable progress has been made along this desirable line of investigation and a number of standards of food products have already been fixed by proclamation. It is proposed to extend this useful work until practically all the substances used by our citizens as foods, beverages, and condiments shall have a fixed standard of purity to which all manufacturers may attain by proper care in the preparation of products of this kind.

EXPERIMENTS WITH BORAX IN FOOD.

The work of the Bureau of Chemistry in the study of the effect upon digestion and health exerted by preservatives, coloring matter, and other substances added to food has been continued in the same painstaking and thorough manner as in the preceding year. The great quantity of data secured in this work in relation to the effect of borax has been compiled and is now being published. These studies of the effect of borax have led to certain definite conclusions which are of the utmost interest to manufacturers of food products into which borax has often been introduced, and to the consuming public.

The effects of the preservatives upon the functions of the body have been studied in detail. It is admitted that there is a necessity for mineral substances in the blood, as they are essential to the functional activity of the various organs of the body, irrespective of any part they may take in direct nutrition. The necessity, for example, of saline solutions in the blood is known to every physiologist, but it is evident that these saline solutions can be derived from materials of common occurrence and naturally found in food products, or usually added thereto as condiments, such as common salt.

At the same time it must not be forgotten that this does not excuse the introduction of other soluble bodies which have a detrimental effect upon the functional activities, and the excretion of which imposes an additional burden upon the excretory organs. For although such substances might not impair the efficiency of these organs for a number of years, they would finally produce a condition of exhaustion which would be followed by serious consequences.

USE OF SMALL QUANTITIES AS PRESERVATIVE.

The argument that small quantities of deleterious substances may be used without harm is not logical, nor can it be based upon the result of the experiments which have been made. On the other hand, the logical conclusion which seems to follow from the data at our disposal is that the use of boric acid and equivalent amounts of borax should be restricted to those cases where the necessity therefor is clearly manifest, and where it is demonstrable that other methods of food preservation are not applicable, and that without the use of such a preservative the deleterious effects produced by the foods themselves by reason of decomposition would be far greater than could possibly come from the use of the preservative in minimum quantities. In these cases it would also follow, apparently as a matter of public information, and especially for the protection of the young, sick, and debilitated, that each article of food should be plainly labeled and branded, so as to show the character and quantity of the preservative employed.

EFFECT UPON HEALTH OF VARYING AMOUNTS OF BORAX.

The most interesting of the observations which were made during the progress of the experiments was in the study of the direct effect upon health of boric acid and borax when administered in food. When boric acid or its equivalent in borax is taken with the food in small quantities, not exceeding half a gram (7½ grains) a day, no notable effects are immediately produced. The medical symptoms of the cases

in long-continued exhibitions of small doses, or in large doses extending over a shorter period, show in many instances a manifest tendency to diminish the appetite and to produce a feeling of fullness and uneasiness in the stomach, which in some cases results in nausea, with a very general tendency to produce a sense of fullness in the head, which is often manifested as a dull and persistent headache. In addition to the uneasiness produced in the region of the stomach, there appear in some instances sharp and well-located pains which, however, are not persistent. Although the depression in the weight of the body and some of the other symptoms produced persist in the after periods, there is a uniform tendency manifested after the withdrawal of the preservative toward a recovery from the unpleasant sensations in the stomach and head above mentioned.

The administration of boric acid to the amount of 4 or 5 grams per day, or borax equivalent thereto, continued for some time, results in most cases in loss of appetite and inability to perform work of any kind. In many cases the person becomes ill and unfit for duty. The administration of 3 grams per day produced in many cases the same symptoms, although it appeared that a majority of the men under observation were able to take 3 grams a day for a somewhat protracted period and still perform their duties. They commonly felt injurious effects from the dose, however, and it is certain that the normal man could not long continue to receive 3 grams per day.

In many cases the same results, though less marked, follow the administration of borax to the extent of 2 grams and even of 1 gram per day, although in some of the cases studied the illness following the administration of borax and boric acid in those proportions may be explained by other causes, chiefly la grippe.

The administration of borax and boric acid to the extent of one-half gram per day yielded results markedly different from those obtained with larger quantities of the preservatives. This experiment, conducted as it was for a period of fifty days, was a rather severe test, and it appeared that in some instances a somewhat unfavorable result attended its use. On the whole the results show that one-half gram per day is too much for the normal man to receive regularly. On the other hand, it is evident that the normal man can receive one-half gram per day of boric acid, or of borax expressed in terms of borac acid, for a limited period of time without much danger of impairment of health.

It is, of course, not to be denied that both borax and boric acid are recognized as valuable remedies in medicine. There are certain diseases in which these remedies are regularly prescribed, both for internal and external use. The value which they possess in these cases does not seem to have any relation to their use in the healthy organism except when properly prescribed as prophylactics. The fact that any remedy is useful in disease does not appear to logically warrant its use at any other time.

It appears, therefore, that both boric acid and borax, when continuously administered in small doses for a long period or when given in large quantities for a short period, create disturbances of appetite, of digestion, and of health.

TESTING OF ROAD MATERIALS.

The work of the Road Material Laboratory, now the Division of Tests, has been much broadened and its value and importance increased during the past fiscal year. The routine tests on road materials are carried on as usual, and several of the tests have been improved and standardized. The importance of testing rocks to be used in road building is being recognized at the present time by the leading highway engineers of the country, and a number of laboratories modeled after the Department Road Material Laboratory have been established in different places.

STUDY OF CLAYS FOR ROAD MAKING.

Of the 228 samples of road materials reported for the past year, 35 were clays. This is mentioned to show the high percentage which clay bears to the whole number of samples received; for it is a fact not generally recognized that in vast areas throughout the country clay is the only material of which roads can be built. For this reason much time has been spent in studying the physical properties of clays in the endeavor to devise methods by which they can be utilized in road making. It may be mentioned here that up to the present time but one method of using clay in road building has been known—that is, to mix it in the proper proportion with sand. This method, however, is not always practicable, for in many districts sand is difficult to obtain. Many of the Western railroads running through areas of the country where rock ballast was impossible to obtain have been in the habit of burning or clinkering clay with open wood and coal-slack fires along the line of their roads. This clinkered clay has been successfully used for some time past as a railroad ballast.

Many inquiries had been received as to methods of treating roads in some of the Western and Southwestern States, where, owing to absolute lack of hard materials and to the extremely sticky nature of the country clays, many of the farmers were absolutely cut off from the towns during the wet portions of the year. It was apparent that if the local clays could be cheaply burnt to a hard, dense clinker a good road material could be provided. Preliminary to actual work on a large scale and expensive experiments on the ground, it was necessary to make laboratory tests of the clays to see whether they would burn to a dense, hard clinker. Samples of the well-known so-called gumbo clay were sent to the laboratory from the Yazoo district of Mississippi. These samples were experimentally burned in the laboratory of the Division, and it seemed quite possible to use the clays in the manner as indicated above.

Following upon this experiment, the Office of Public Road Inquiries built an experimental road in Yazoo City which has been reported successful. It is needless to point out the great importance of the success of such experiments in relation to road building in localities in which no rock is to be had.

IMPORT AND DOMESTIC PRODUCTION OF CLAYS.

Since it is shown by many letters of inquiry that information is being sought by people all over the country on the subject of testing

of clays for the various purposes for which they are used, other than road building, special tests are now carried on to that end. A furnace has been installed and actual burning tests on clays are now made. In order to further stimulate interest in the development of native clay bodies, a special circular was issued on "The useful properties of clays." The aim of this circular was to give information in the simplest possible way to people who were not supposed to possess technical knowledge of clays. That the object has been attained is shown by the increased correspondence of the Division on this subject. The circular particularly points out that for the year 1902, the last year for which the official figures are available, the total imports of foreign clays to this country were valued at $1,154,805, while the domestic clays produced were valued at $2,061,072. Since the country possesses unusually fine clay bodies, a great many of which up to the present time await development, any stimulation of interest among the people to develop our native clays must be of great value.

CEMENTING POWER OF ROAD MATERIAL.

The satisfactory investigation of the important property of binding or cementing of road materials when used upon roads has been continued and much new evidence has been obtained.

Under the old rule-of-thumb methods of road building one sort of rock was supposed to be as good as another. Miles and miles of expensive roads have been built in a haphazard way, of any sort of material that was available, and many of such roads have "raveled" and gone to pieces almost as rapidly as they could be built. Since the establishment of the proper methods of testing and investigating these materials, there has been noticed a great improvement of roads. The most intelligent and progressive of the State highway engineers are availing themselves of the opportunities extended to them by the Department of Agriculture for studying and familiarizing themselves with the physical properties of the materials which they are about to use before risking the public moneys in expensive work.

The hardness and toughness of a rock which is going to be used on a road are, as everyone knows, important properties, but the property which causes this rock under the influence of traffic to bind or cement together so as to form a smooth, even, impervious shell on the surface of a road is even more important. When the work of the Road Material Laboratory first began the importance of this quality had hardly been recognized, and absolutely nothing was known as to the reason why one rock should possess this property to a very high degree and another of perhaps identically the same name and species should be entirely lacking in it. The closest investigation has been given to this subject and to the collection of all possible data and information, not only from the theoretical and laboratory standpoint, but also from a practical point of view. It is safe to say that its satisfactory solution has been accomplished. A bulletin on "The Cementing Value of Road Materials" has just been published, and the publication of more work in the same line will follow shortly.

A new test for determining the toughness of rock and asphalt mixtures for road building was brought out during the past year, and several new tests are at present being developed.

CONCRETE FOR FENCE POSTS, ROOFS, ETC.

On the 1st of last July the Road Material Laboratory was made a Division, and its name changed to the Division of Tests. The object of this change was to establish in the Department a laboratory where all materials of construction relating to agriculture could be tested and allied problems investigated. In pursuance of this change, several lines of research have been taken up. The first problem selected was to determine whether or not a thoroughly practical concrete fence post reenforced with steel could be made sufficiently cheap to be used by farmers. The advantages of such fence posts would be many. The price of wood, particularly of the varieties used for fence posts, is continually rising, and even now the price is almost prohibitory in some sections of the country. Further, a properly constructed concrete fence post would be permanent, as it would neither rot nor undergo disintegration. A variety of methods of reenforcement have already been tried, and the experiments are being pushed as rapidly as possible. The results so far obtained have been most satisfactory.

Experiments of a similar nature to the above are about to be begun on methods for making concrete drains, watering troughs, roofs, and barns, with the hope that concrete construction, so rapidly developing in the large cities, can be applied with benefit to the farm.

The question of the structure and constitution of hydraulic cements is a matter of the very greatest importance. The Division of Tests has in preparation a paper which I have good reason to believe will be accepted as the solution of this much-discussed question.

USE OF OIL ON ROADS.

Much interest has been felt in different parts of the country in the use of oil for treating the surfaces of highways, in order to lay the dust and to offer a hard, impervious, waterproof surface. It is well known that in California such treatment of roads has met with a high degree of success. Similar experiments, however, when carried out in the East, proved complete failures; the Eastern oil failed to bind on the surface of the road, and did not lead to the desired result. When it was found that the main difference between the California natural oils and the Eastern and Texas oils lay in the fact that the California oils contained an asphalt base, while the Eastern oils contained a petroleum or vaseline base, the Division of Tests immediately suggested that the cause of the failure of previous Eastern experiments was directly due to this fact, and road builders throughout the country were urged to make experiments with mixtures of crude oils with crude asphaltum. Last summer the Commissioners of the District of Columbia consented to make such an experiment. A street in Washington was selected for the purpose and a number of mixtures of Southern crude oil and asphaltum were spread in adjacent sections. At first the experiment was looked upon as a failure, but the road has been steadily improving, and at present there is every promise of the experiment proving a success. If it proves true that mixtures of Eastern crude oil and asphaltum make as good roads as the California oils do, a very great advance will be made toward the betterment of our rural highways.

SCHOOL FOR ROAD BUILDING.

One of the chief lines of work for this division during the present year is the establishment of a school of road building. The object of

this school is to give a one-year course in highway engineering and the testing of road materials to about four young men who have received degrees from reputable engineering schools. These students are to be selected by a civil-service examination. They will devote six months to the study of road-building problems and road materials and six months to field work, which will consist of actual road construction. Men with such training are sure to be of the greatest service to the country, not only in constructing highways, but in disseminating accurate knowledge on highway construction.

BUREAU OF SOILS.

The study of soils and their management with regard to their values for producing crops has been continued. The composition of soils varies greatly in different localities and in quite limited areas. Our soils were nearly all fertile originally, but continued cultivation has in many cases reduced their powers to grow crops as they did when first brought under the plow. The best methods of restoring soils that have been cultivated too long is a pressing question not only in the older settled States, but is insistent in most of the newer lands of the West where wheat has been grown until profitable crops of it are no longer to be had.

Rotation of crops and laying down in pastures to be grazed until the soil fills with roots is the well-known restorative, but soils vary greatly in our several States and are adapted to the growth of special crops in our several latitudes, so that a general knowledge of their composition is of prime importance before the tiller can put them to their most profitable uses. Droughts limit the yield on soils that have lost their organic matter through continued cultivation without an adequate return of fertilizers in the shape of decaying vegetation. Commercial manures will not adequately remedy the evil, as they do not return to the soil what enables it to retain moisture. Soils vary so much in this regard, from coarse sand to retentive clay, that each requires careful study to enable the farmer to manage it to the greatest advantage.

The Bureau of Soils is mapping our various areas to the end that the residents on each may as soon as possible learn the peculiarities with which they have to deal. This work is comparatively new. Its value has been overlooked by the educator. A force of soil experts is being trained in the Department to help the cultivator to a better knowledge of the possibilities of his acres throughout our broad land, in order that run-down lands may be reclaimed and that the fertility of our newer lands may be maintained to meet the requirements of a rapidly increasing population.

We are bringing plants from all foreign countries to diversify our industries and enable our husbandmen to grow what has been and still is costing us large amounts of money. A knowledge of the character of the soils from which they come and on which they have been developed is imperative, and suggests to us the wisdom of becoming familiar with the soils as well as the climates to which we introduce them, if we are to maintain them here in their excellence or improve them, giving them better conditions than they had in the countries where we found them. Within the limits of our climates and soils we hope to improve everything we import through a superior aggrega-

tion of scientists who are making research into all the conditions of plant life, the soil being of greatest importance.

PROGRESS OF THE SOIL SURVEY.

The area surveyed and mapped during the fiscal year was 29,058 square miles, or 18,597,120 acres. The area surveyed during the preceding fiscal year was 23,293 square miles, which, together with the work done prior to that time, makes a total area surveyed up to that date of 74,795 square miles, or 47,868,800 acres.

The work was carried on during the past year in 68 areas in 33 States. On an average 20 parties have been working continuously throughout the year, in the Southern States during the fall and winter and in the Northern States during the spring and summer months.

The areas surveyed and the cost of the work in each area are shown in the following table:

Areas surveyed and mapped during fiscal year ended June 30, 1904, and the areas previously reported.

State or Territory.	Work during 1904.	Work previously reported.	Total area surveyed.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
Alabama	2,396	1,223	3,619	2,316,160
Arizona	.....	611	611	391,040
Arkansas	626	251	877	561,280
California	1,679	3,921	5,600	3,584,000
Colorado	228	1,345	1,573	1,006,720
Connecticut	.....	518	518	331,520
Delaware	314	.....	314	200,960
Florida	485	548	1,033	661,120
Georgia	853	757	1,610	1,030,400
Idaho	58	1,077	1,135	726,400
Illinois	2,333	3,592	5,925	3,792,000
Indiana	889	387	1,276	816,640
Iowa	1,287	1,016	2,303	1,473,920
Kansas	999	464	1,463	936,320
Kentucky	.....	837	837	535,680
Louisiana	1,446	942	2,388	1,528,320
Maryland	29	2,634	2,663	1,704,320
Massachusetts	386	410	796	509,440
Michigan	517	858	1,375	880,000
Minnesota	.....	233	233	149,120
Mississippi	1,352	1,317	2,669	1,708,160
Missouri	1,111	919	2,030	1,299,200
Montana	.....	107	107	68,480
Nebraska	1,195	.....	1,195	764,800
New Jersey	.....	1,303	1,303	833,920
New Mexico	.....	129	129	82,560
New York	986	1,558	2,544	1,628,160
North Carolina	687	4,646	5,333	3,413,120
North Dakota	386	856	1,242	794,880
Ohio	1,400	1,355	2,755	1,763,200
Oregon	60	386	446	285,440
Pennsylvania	.....	1,204	1,204	770,560
Porto Rico	.....	330	330	211,200
Rhode Island	500	.....	500	320,000
South Carolina	1,159	2,032	3,191	2,042,240

Areas surveyed and mapped during fiscal year ended June 30, 1904, and the areas previously reported—Continued.

State or Territory.	Work during 1904.	Work previously reported.	Total area surveyed.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
South Dakota	.....	485	485	310,4[illegible]
Tennessee	1,596	547	2,143	1,371,5[illegible]
Texas	2,564	1,733	4,297	2,750,0[illegible]
Utah	306	994	1,300	832,0[illegible]
Vermont	227	.....	227	145,2[illegible]
Virginia	656	2,747	3,403	2,177,9[illegible]
Washington	.....	510	510	326,4[illegible]
West Virginia	39	.....	39	24,9[illegible]
Wisconsin	.....	955	955	611,2[illegible]
Wyoming	309	.....	309	197,7[illegible]
Total	29,058	45,737	74,795	47,868,8[illegible]

RECAPITULATION.

Cost of field work	$64,235.3[illegible]
Supplies	1,464.1[illegible]
Traveling expenses between areas	4,115.5[illegible]
Other expenses	2,786.3[illegible]
Total cost of soil survey	72,601.4[illegible]
Paid by State organizations	2,377.5[illegible]
Paid by Department of Agriculture	70,223.8[illegible]
Area surveyed ..... square miles	29,05[illegible]
Cost of work in field per square mile	$2.21
Transportation, supplies, and other expenses, per square mile	.[illegible]9
Average total cost per square mile	2.5[illegible]
Average cost to Department of Agriculture per square mile	2.4[illegible]

The cost of the work in the field has increased from $2.19 per square mile, reported last year, to $2.21 per square mile during the year just closed; while the average cost of the work to the Department of Agriculture, including all transportation, supplies, and office expenses, has decreased from $2.63 per square mile, reported last year, to $2.42 per square mile during the year just ended.

There has been a continued demand for this soil-survey work, and there are on file demands for about two years' work yet unfilled, while requests continue to come in which can not be immediately considered.

There has been a steady demand from colleges, experiment stations, and private enterprises for men trained in this soil-survey work, and during the past year several men have left this Bureau to accept more lucrative positions elsewhere.

PUBLICATION OF THE REPORTS AND MAPS.

At the last session of Congress provision was made to print in the form of "advance sheets" the several reports as they are prepared—500 copies for the use of each Senator from the State, 2,000 copies for the use of each Representative of the Congressional district or districts in which the survey is made, and 1,000 copies for the use of the Department of Agriculture. Although this act was passed too late to materially influence the printing of the report of the work for the field season of 1903, it will very greatly facilitate the distribution of the report and is proving a very advantageous way for the printing and distribu-

tion of the report of the work for the field season of 1904, the manuscript of the first reports of which have already gone to the Public Printer.

ALKALI-LAND RECLAMATION.

In my last report attention was directed to the important results obtained in the reclamation of alkali soils by underdrainage and surface flooding. This work was undertaken as an object lesson to farmers in those irrigated districts of the West where any considerable trouble had been experienced with the rise of alkali and the consequent depreciation in the value of the land. The results of the past year have again proved the wisdom of inaugurating these demonstration experiments in alkali reclamation. Great interest in the work has been aroused on every side, and frequent inquiries have been received from farmers owning alkali land asking instructions as to the best methods to prevent the further deterioration of their lands and advice as to the reclamation of tracts now partly or wholly unproductive.

On the reclamation tracts established during 1902–3 much progress has been made during the past year, and indications point to the complete reclamation of the lands under experimentation at an early date. On the 40-acre Swan tract, near Salt Lake City, the results have been especially gratifying. At the inception of the work there, in September, 1902, a detailed soil survey showed the first 4 feet of soil over the 40 acres to contain more than 6,650 tons of soluble salts (alkali). In May, 1903, there had been removed in the drainage water, by actual measurement, nearly 50 per cent of this immense total, and in the October following the proportion removed had reached 82 per cent, thus leaving only 1,221 tons of the original 6,650 tons still in the 4-foot section of the entire tract. The greater part of the salt originally in the surface foot had been removed, while even the fourth foot had lost 69 per cent of the alkali originally present.

In the spring of 1904 this tract was sowed to oats, barley, and wheat, as it was believed to be sufficiently sweetened for shallow-rooted crops. The land was not in the best condition for seeding. Nevertheless, on many of the checks 90 per cent of a stand was secured, and on all checks but little evidence of alkali was observed. The flooding process was resumed on those checks having the poorest crop prospects, and will be continued on all the tract after harvest, and by next spring it is expected that reclamation will have progressed to such an extent that the deep-rooted alfalfa can be grown, when the land will be returned to the owner. The growing of the crops of the present year and the seeding of the land to alfalfa are under the control of the Utah experiment station in cooperation with the Department.

The progress of a similar work on a 20-acre tract at Fresno, Cal., has been no less gratifying than that at Salt Lake City. The problem here as regards the drainage was more difficult, as the water had to be removed by pumping, while the soil was fine and silty and clogged the drain pipes. These difficulties have been surmounted, however, and within a year it has been possible to grow crops of alfalfa and wheat on a considerable part of the 20 acres under experiment. The Fresno work I deem particularly important, as it is situated in a wealthy district, where large areas of once productive land have been abandoned because of the rise of alkali and the swamping of areas by

seepage water from the excessive irrigation of higher lying lands and from the canals.

In the Gervais tract, situated 3 miles from North Yakima, Wash., it is estimated that flooding from July to November, 1903, washed approximately 70 per cent of the total salts out of the soil to a depth of 4 feet. Here, as in the Fresno area, much valuable land has been ruined by seepage water and the rise of black alkali. Flooding of this tract was resumed in 1904, and it is expected that reclamation will have progressed to such an extent that crops can be grown in the coming season.

A more recent experiment has been instituted at Tempe, Ariz., where the installation of the drains was completed in February, 1904. An unprecedentedly dry season and a consequent lack of water have prevented much progress in the work at this point.

Another tract has been taken up for reclamation work near Billings, Mont. This tract is situated in the Yellowstone River Valley, where great progress has been made in growing alfalfa as a winter feed for the cattle and sheep that pasture on the adjoining mountain ranges during the summer. Shortly after irrigation began in this district alkali began to appear and the ground water rose rapidly, waterlogging wide areas of the land to such an extent that its cultivation had to be discontinued. An examination of certain parts of the valley, made by the Bureau of Soils in 1897 and 1898, showed the extent of the damage, and when, in 1902, a detailed soil survey was made around Billings it was found the trouble had greatly increased and intensified. Even in the two years that have elapsed since the survey was made, many fine alfalfa fields have been abandoned and now are heavily incrusted alkali flats. The farmers here are fully alive to the seriousness of the situation, but seem unable to cope with the problem.

Many tracts of land were offered the Department for the purpose of experiment, and a number of farmers have indicated their intention to undertake similar work themselves, showing the interest taken in the work. This, however, has not proceeded far enough to permit a full report at this time. I have, however, the fullest confidence in the final success of the undertaking, as well as a firm belief that it will lead to individual or concerted action on the part of those of our citizens most interested, with the result that both the agricultural and stock-raising interests of this part of the country will be greatly benefited.

It seems, then, that within three years, at most, practically worthless land, so heavily charged with injurious salts as to be unfit for any form of agriculture, may be reclaimed to grow any ordinary field crop; that the method of doing this is simple; and that the expense involved is such that the work may in many instances be economically undertaken by individual, corporate, or State initiative. Taking the Utah tract for example, the land reclaimed has increased from a purely nominal value to an actual value, judged by the value of surrounding unaffected lands, of $250 to $300 an acre. The total expense of reclamation, taking everything into consideration, is but a small fraction of this enhanced value.

TOBACCO INVESTIGATIONS.

In the line of tobacco investigations carried on by the Bureau of Soils the most important work during the past fiscal year has been the

experimental growing of Cuban seed tobacco on certain soils in Texas, Alabama, and South Carolina. This work was begun in July, 1903, in cooperation with leading farmers in the several States. Thirteen acres were planted in Texas, 3 in Alabama, and 3 in South Carolina. The success of this first trial led to further plantings by the Department in 1904, when trial tracts were established at Nacogdoches, Crockett, and Giddings, in Texas, a total of 12 acres being planted. One tract in Perry County, Ala., and one in Orange County, S. C., were established, each with 3 acres in tobacco. Samples of the tobaccos grown in 1903 were submitted to the trade, and the opinion is that the Texas leaf has considerable merit, both in regard to flavor and aroma, and some have pronounced it to be superior to any filler yet grown in this country. The Alabama filler leaf is considered fair, but not equal to the Texas leaf, while the filler grown in South Carolina does not meet with as much favor as that grown in the two States already mentioned.

The commercial value placed upon this leaf by different tobacco brokers varies considerably, ranging from 18 to 40 cents a pound.

Some bales of Texas leaf have been disposed of at the higher figure. Final judgment of the success of this venture must be postponed until further advices are received from the dealers and manufacturers to whom working samples have been submitted.

GROWING AND CURING CIGAR TOBACCOS IN OHIO.

Experiments in growing the Cuban type of filler have also been carried on on a 10-acre tract in Ohio. Owing to the heavy nature of the leaf it is impossible to judge of its aroma at present. The tobacco of this type raised in the preceding year is only just ready for the manufacturer. The aroma has been pronounced good, but it is believed that the leaf is too heavy for the taste of the general public and the aim this year is to try to produce a somewhat lighter leaf. The results of these experiments in growing Cuban filler leaf seem to warrant a continuation of the experiments in the Southern States and possibly in Ohio for the succeeding year upon somewhat broader lines; and it is hoped that through the efforts of the Bureau of Soils an extension of the domestic filler leaf interests may be accomplished.

By far the most important work in Ohio, however, has been the further introduction of the bulk method of fermenting cigar tobaccos. This work was begun in 1902, when 655,200 pounds were fermented. In 1903, 4,204,800 pounds were fermented, and in 1904 the quantity was increased to 10,208,000 pounds, distributed among the several types of tobacco as follows: Zimmer Spanish, 5,850,000 pounds; Little Dutch, 582,000 pounds, and seed leaf, 3,776,000 pounds. As the work of the Department there is simply supervisory, and entails the cooperation of the warehousemen, this great increase evidences the remarkable interest that this change in the methods of handling tobacco has to the grower and the tobacco dealer. Its use not only avoids great loss formerly suffered from fungous growth in the case-fermented tobaccos, but also tends to improve the grades of tobacco and therefore increase the profits both to the grower and the handler.

WRAPPER LEAF IN CONNECTICUT.

The experiments in the production of a wrapper leaf in the Connecticut Valley have been continued during the last year. In the begin-

ning of these experiments in 1900, work was undertaken in cooperation with the Connecticut experiment station at Poquonock, on one-third of an acre of land. The tobacco grown on this small plot was submitted to leading leaf dealers and brokers in New York for their opinion. On their judgment, which was very favorable, the Department felt justified in conducting further work in Connecticut upon a considerably larger scale. In 1901, therefore, 40 acres were planted, this time in cooperation with leading tobacco growers in the valley. This tobacco was of satisfactory quality and was sold at Hartford, and although it had been grown under very unsatisfactory climatic conditions a very good price was obtained at the sale. In 1902 a larger acreage was planted by the Connecticut farmers; and leaf dealers of New York—men who had spent their lives in the tobacco trade and who were everywhere recognized as good judges of tobacco—invested money in the production of shade-grown tobacco, not upon the reports of the Bureau of Soils, but on their own judgment of the satisfactory character of the leaf.

Owing to unfavorable climatic and adverse trade conditions, which were entirely beyond the control of the grower, the tobacco produced during that season failed, to a certain extent, to meet the demands of the manufacturers. The climatic conditions in 1903 were very similar to those in 1902—that is, they were unfavorable to the production of a wrapper leaf of the very best grade, and there was not so large a demand for this tobacco as was expected. In 1903 the Bureau had practically ceased its work in Connecticut; but in 1904, still having confidence in the opinion of the trade, and believing that the method of growing tobacco for wrappers under shade is correct, it has conducted an experiment at Tariffville, Conn., where a crop has been produced on a 4-acre plat. Owing to the recent tendency on the part of the trade to wrap the better grades of cigars with the Cuban rather than with the Sumatra style of leaf, 1 acre of this plat was planted to Cuban seed tobacco.

Tobacco of this type grown under shade in Connecticut was exhibited by the Department at the Louisiana Purchase Exposition at St. Louis, and to it was awarded the grand prize as being a leaf of the highest standard of excellence for cigar wrappers.

In connection with this matter of the producing of shade-grown wrapper in Connecticut, the Bureau of Soils has been making an investigation as to the demands of the market for the Cuban type of leaf and as to the practicability of building up a demand for Connecticut shade-grown tobacco of this type. Recent sales of this tobacco have been made, principally in New York and Philadelphia, and the following table shows the distribution of nearly 300 bales of such tobacco and the average price per pound of the lots as sold:

Prices received for Connecticut shade-grown tobacco.

For domestic use, 134 bales:		
Bales, 17	per pound..	$1.75
1	do....	1.65
24	do....	1.50
3	do....	1.45
3	do....	1.40
4	do....	1.35
60	do....	1.25
1	do....	1.00
1	do....	.75
For domestic use, 134 bales—Continued.		
Bales, 16	per pound..	$0.62½
4	do....	.35
For export, 144 bales:		
Bales, 14	do....	.70
30	do....	.32½
100	do....	.30
Tops, 104 bales:		
Bales, 90	do....	.10
14	do....	.08

This table shows that 134 bales have been sold for domestic use at an average price of $1.26 8/10 per pound, the highest price being $1.75 per pound for light wrappers, and the lowest price 35 cents per pound for short-sized second-quality leaf. The 144 bales sold for export, at an average price of $0.34 4/10, consisted of tobacco of a quality not suited to the home market, principally of sand leaves and short-sized, flimsy tobacco. Nearly all of this tobacco was shipped to the German market. The 104 bales, sold at an average price of $0.09 7/10, consisted of short top leaves, the tobacco having no wrapper quality, and being useful only as an inferior filler.

The tobacco experts of the Bureau of Soils see no reason to change their belief that the method of growing tobacco under shade in the Connecticut Valley will produce a wrapper leaf of great excellence, which can be economically used by the trade, and it would seem that the industry should be established upon a commercial scale.

IMPROVING EXPORT TOBACCOS.

Up to the beginning of last year the tobacco work of the Bureau of Soils has been along the lines of improving the methods of culture and handling of the cigar tobaccos, but this year considerable demand has been made upon the Bureau to assist the growers of the heavy export types of tobacco. The low percentage of tobacco suitable for plug wrappers, and the poor price obtained by the majority of growers, have led the Bureau to make investigations into the production of this type of tobacco, the object being to see if both the yield per acre and the percentage of the higher grades could be increased. A 5-acre experimental plot in Appomattox County, Va., was selected for studying the problem. In this section the finest plug wrappers are grown, and the work would also be carried on close to the Richmond and Lynchburg markets. It is the plan of these experiments to grow the tobacco with different fertilizers and under different methods of culture, to see which will give the best financial results to the grower. It is the intention of the Bureau to extend this work in the future to other districts producing the shipping types of tobacco. It is yet too early to give the results of the present season's work.

BUREAU OF ENTOMOLOGY.

Insect pests cause a loss to the staple crops of the United States estimated at some $500,000,000 annually. The main object of the Bureau of Entomology is to make thorough studies of the insects responsible for these losses and to apply the information gained to limiting or preventing them. The Mexican cotton boll weevil represents the most important field of work of this Bureau during the last few years, but the insect enemies of the cereals, fruits, and other staple productions have been the subject of careful study and experimental work. The results of this work have been notably successful, particularly in the case of the boll weevil and the bollworm.

THE MEXICAN COTTON BOLL WEEVIL.

Congress originally provided $30,000 for the continuation of the investigation of the boll weevil and the bollworm for the fiscal year.

DEMONSTRATION FARMS.

Under this appropriation seven experimental farms were organized in Texas, located at Victoria, Wharton, Austin, San Antonio, Calvert, Willspoint, and Hetty, all together aggregating 558 acres of cotton. The seven localities represented typical variations in soil and climatic conditions of Texas, and enabled the Department to test various methods of controlling the boll weevil under different conditions. They included bottom lands, dry upland subject to irrigation, the black prairie land of Austin, and the soils of river valleys where the presence of timber and moist climate and almost exclusive production of cotton renders the weevil problem more serious than elsewhere. Other farms were on the high, rolling prairie land and river bottoms of the northern part of the State.

The minute investigation of the life history of the weevil, upon the knowledge of which any system of control of the pest and any modification of the present cultural system must naturally be based, was continued at the laboratory at Victoria. In the experimental fields attached to this laboratory also were tested poisons and machines. An expert assistant carried on a study of the weevil in Cuba, one of its native regions, with the hope of finding some effective parasite or some variety of cotton especially resistant to its attacks.

The exact spread of the boll weevil into new cotton regions was determined, and a special investigation of the usefulness of birds in controlling the weevil was instituted. The result of the work of the season of 1903 is summarized in three important publications issued by the Bureau.

Under the provisions of the special appropriation of $250,000 made available January 15, 1904, it was possible to greatly enlarge the work.

The number of experimental or demonstration farms was increased to thirteen for the season of 1904, aggregating 1,077 acres. During the previous season in not one of the seven experimental farms then under operation did the crop fall appreciably below the average production in the United States before the weevil came into Texas, namely, about half a bale to the acre. The cultural system which these farms were designed to illustrate has so far proved to be the only practicable means of controlling the boll weevil, and the work of past years has demonstrated its general success and feasibility. It is the outgrowth of several years of field experiments conducted by the Bureau of Entomology in Texas. The cotton on these farms is planted under a contract which gives the Department complete control of the culture of the crop.

SCIENTIFIC AND LABORATORY WORK.

In addition to the conduct of these demonstration farms, the more purely scientific and laboratory work relating to the study of details of the life history of the weevil and of the possibility of artificial propagation of parasites has been increased. Special work has been done in the attempt to eradicate isolated colonies, to control the danger of dissemination of the weevil by the gins and gin products, notably cotton seed, and the perfecting of quarantine plans to check or prevent the spread of the weevil from Texas to other cotton-growing States.

COOPERATION WITH THE LOUISIANA BOLL WEEVIL COMMISSION.

The weevil having already crossed the line into Louisiana, the Bureau of Entomology has been doing cooperative work with the Louisiana boll weevil commission in eradicating colonies in Louisiana and preventing its further spread into that State, with the idea of protecting not only Louisiana but the more eastern cotton regions. The work of this year has been most successful so far as the experimental farms and other work in Texas are concerned. It has proved impossible to exterminate the weevil in Louisiana, its distribution in the western counties of that State having become already too wide. Nevertheless its spread has been very greatly checked, and by proper quarantine and exterminative work its eastern progress can be very much delayed.

COLONIZATION OF THE GUATEMALAN ANT.

The Guatemalan ant, which was discovered by Mr. O. F. Cook, botanist in charge of investigations in tropical agriculture of the Bureau of Plant Industry, and which seems to be a very efficient enemy of the cotton-boll weevil in Guatemala, has been the subject of careful experimental work, begun under the Bureau of Plant Industry and afterwards transferred to this office, but remaining under the charge of Mr. Cook. This ant, determined by experts of the Bureau of Entomology as *Ectatomma tuberculatum*, is a tropical species of rather wide distribution throughout Central America and northern South America. Its specific habits were unknown prior to its discovery in Guatemala, but in this region, according to Mr. Cook, it seems to be an important natural enemy of the boll weevil. Nearly a hundred colonies of this ant, representing some 4,000 individuals, were conveyed to Texas, and have during the summer been placed at different points, and are being made the subject of careful study to determine whether this ant offers any hope of control to any extent of the boll weevil under the climatic conditions of Texas. The practical results of this importation can not now be foretold. The ant has, however, maintained itself during the summer, which is a feature of distinct encouragement.

THE BOLL WEEVIL STILL A MENACE.

The future work against the boll weevil in Texas and other Southern States will depend upon the action of Congress. The National menace still exists. The cotton planters of Texas have not all become convinced of the benefit to be derived by following the advice which the Bureau is enabled already to give, based upon its investigations of the past ten years, and therefore further investigation and further demonstration work seem to be necessary. Moreover, the imminent danger of the spread of the weevil to other cotton States indicates the necessity that the General Government should keep a force of men in the field to prove to the entire satisfaction of the planters the value of its advice, to continue the study of the insect in its rapidly changing environment, and to assist in quarantine measures and such other means as are necessary to restrict the spread of the pest.

THE COTTON BOLLWORM.

The work on this insect, which is the second worst pest of the cotton and ranges throughout the cotton belt, has been continued during the last two seasons. The work during the season of 1904 has been much increased as a result of the special appropriation made available in January of this year. The principal lines of investigation followed out are field experiments in methods of control, and laboratory and field investigations of life history, habits, and parasitic and predaceous enemies of the insect. The field experiments have demonstrated that the cultural system of control recommended for the boll weevil furnishes the very best means also against the bollworm. The value of spraying and dusting with arsenical poisons and of trap crops was made the subject of careful experiments. This work was done on six contract farms over which the Department had absolute control, as in the case of the boll weevil, representing different localities and climatic and soil conditions. Cooperative work was also done at a number of other points, giving a total of some 400 acres on which experimental and demonstration work was carried on. The work outlined above has been most successful, and the Department is now able to recommend measures which will reduce damage from the bollworm to an inconsiderable amount.

In addition to these two principal cotton pests, other insects depredating on cotton, but of minor importance in comparison with these two, have been the subject of study.

IMPORTED BENEFICIAL INSECTS.

The possibility of keeping injurious insects in check by the introduction and encouragement of natural insect enemies of such injurious species is a very popular subject with fruit growers and farmers, and notable successes have been achieved in this direction. The work in which the Department of Agriculture has been especially interested in this direction during the year has been a continuation of the effort to establish the Asiatic ladybird enemy of the San Jose scale in the Eastern States and the South African black scale parasite in California, together with the kelep or Guatemalan ant enemy of the cotton boll weevil, referred to elsewhere.

The Asiatic ladybird enemy of the San Jose scale (*Chilocorus similis*) maintained itself in numerous colonies in the South during the winter. An examination in Georgia in May last indicated the general presence of the beetle in many of the orchards where it had been liberated. Its rapid multiplication has been prevented, however, in many instances, by the submission of the orchards in question to spraying operations with lime, sulphur, and salt, or other washes, exterminating practically all of the scale food and hence leading to the starvation of many of the beetles. Nevertheless this imported insect has gained foothold and will probably make progress wherever scale food is abundant. Its spread by artificial distribution of colonies has been continued as far as material has been available. The discovery of the efficiency of the lime, sulphur, and salt wash, and the need in commercial orchards of absolutely clean fruit, will operate against this imported insect as against all other parasites of this scale. It is a comparatively easy matter and not expensive to keep an orchard

clean by spraying, and while this is the case it will not be advisable in commercial work to take the slower chance of clearing up by natural enemies, which can never be thorough from the very nature of the case. The successful establishment, however, of this Asiatic beetle in America can not work anything but good, as it is an important agency in the control of scale pests, and will become more efficient in America as it becomes more widespread and abundant.

The black-scale parasite in California (*Scutellista cyanea*) has exceeded in usefulness the most sanguine expectations, and has demonstrated that it can withstand the winter climate of California perfectly. The black scale of which it is an enemy is the worst pest of the citrus industry in southern California, and this imported parasite is the first agency which has offered any real hope of control other than by direct spraying or gassing operations. As an illustration of the prolificacy of this parasite, more than 40,000 specimens were distributed from the office of the Los Angeles County horticultural commissioners, and vast numbers were distributed from other centers.

The older importations of beneficial insects, such as the enemy of the white scale of citrous and other fruits in California and the *Rhizobius ventralis*, useful against the black scale in the moist regions of the Pacific coast, have continued their rôle of distinct usefulness, the first named being the most striking case of benefit ever made by an imported insect. The fig-fertilizing insect has enabled the raising of another very large and fine crop of Smyrna figs in the vicinity of Fresno, Cal., and the development of the fig industry seems perfectly assured, and only awaits the necessary lapse of time for new orchards to become established.

SCALE INSECTS.

The work with scale insects has been actively prosecuted during the year. This group of insects includes some of the most important enemies of fruit trees and shrubbery, and in the South also of various field and garden crops. The small size of most of these scale insects, and the necessity of making careful microscopic preparations of them before determination can be made, render their identification by field observers difficult, if not impossible. The result is that a great deal of the work of determination comes to this Department from State entomologists and horticulturists, as well as from foreign sources.

INSECTS DAMAGING FORESTS.

The work on tree pests is carried on in cooperation with the Bureau of Forestry. During the present year it has related particularly to (1) insect damage in the forests of the Black Hills region, a continuation of the work begun in 1902; (2) an investigation of important timber trees in the State of Washington, particularly the western hemlock, highland spruce, red fir, and other conifers; (3) at the southern station (Tryon, N. C.), damage to the southern pine and cypress; (4) in the middle Appalachian station, damage to imported mahogany and other timber and lumber by introduced and native insects, and to hickory, oak, and hemlock by bark-beetles and tan-bark insects; (5) at the southwestern station (Flagstaff, Ariz.), damage to pine forests by bark-beetles. In the course of this work there has been considerable cooperation with lumbering companies and manufacturers of articles of

wood, importers of exotic woods, and forest rangers. The general information gained from this study and from laboratory work at Washington has greatly advanced the knowledge of forest insects and the means of controlling them.

INSECTS INJURIOUS TO VEGETABLE CROPS AND TO FRUITS.

The work reported in previous years has been continued in these two important fields of investigation. A subject of special study during the year has been the insect enemies of sugar beets, covering work done from Nebraska and Michigan to the Pacific Coast States and Arizona, with the object of issuing a comprehensive report on the subject. Work on the insect enemies of the orchard fruits, citrous and deciduous, and small fruits has been continued. The cranberry insects have been made the subject of a special publication.

MISCELLANEOUS WORK WITH INSECT PESTS.

A good deal of work has been done during the year in the study of means of controlling damage by insect enemies of stored grains, such as the flour beetles and meal worms, and particularly of the Mediterranean flour moth, one of the worst of mill pests, which has been reported during the year in many new localities, from New York to California.

Insects affecting shade trees and ornamental plants have been studied, as also the important insect enemies of hothouse plants and indoor cultures.

The investigation of insects in relation to the health of man has been continued. The geographical distribution of the yellow-fever mosquito in the United States has been the subject of special investigation, as having an important bearing upon quarantine measures.

A special study has been undertaken of rice insects in South Carolina in cooperation with the South Carolina experiment station.

INSECT ENEMIES OF GRAINS AND FORAGE PLANTS.

An elaborate investigation of insects affecting grains, grasses, and other field crops has been begun, and a special field agent of wide experience and reputation has been put in charge, with assistants and means for the best work. A further investigation will be immediately undertaken of the Hessian fly, the chinch bug, and the cutworms and wireworms and other insects affecting wheat, corn, clover, alfalfa, and similar crops. The damage by insects in this field is greater than in any other on account of the enormous areas under cultivation and the money value of the product.

EXPERIMENTAL WORK WITH INSECTICIDES.

The most important results confirmed by the experimentation of the year with insecticides relate to the use of the lime, sulphur, and salt wash against the San Jose scale. Experimentation with this wash, long used in California against this scale pest, has been going on in the East for several years, and the results now secured have fully demonstrated its very great value in spite of the somewhat

adverse climatic conditions which obtain on the Atlantic seaboard and in the Mississippi Valley. It is a winter application, and very inexpensive as compared with the use of oils and soaps, means hitherto very much employed in the East, and it has the additional very distinct advantage of notable value as a fungicide; so much so in fact that some fruit growers are spraying their peach orchards with this wash, whether they have scale on them or not, simply for its value against leaf curl and other fungi. The usefulness of this wash has very largely decreased the terror which fruit growers have hitherto felt for the San Jose scale.

The possible value of sulphate of copper as a means of controlling mosquitoes, as indicated in a report issued by the office of Vegetable Pathological and Physiological Investigations of the Bureau of Plant Industry toward the close of the year, caused a series of experiments to be instituted by the Entomologist to test the usefulness of this chemical as a means of destroying such larvæ. The results of these tests have shown that it has comparatively small value against mosquito larvæ under normal outdoor conditions of breeding, but it may prove to be quite effective against mosquitoes in regions where water is kept in cisterns or small storage reservoirs, as, for example, in Cuba and in Panama. The experimentation with this substance is still in progress.

An expert has been put in particular charge of all investigations with insecticides and machinery, and the opportunity for practical work has been very much increased. Experiments are now under way with the insecticides referred to above, and also with petroleum oils; also fumigation experiments on fruit stock and buildings and granaries, and work on the composition of insecticides in cooperation with the Bureau of Chemistry are being carried on.

ENTOMOLOGICAL EXHIBIT AT THE LOUISIANA PURCHASE EXPOSITION.

An elaborate exhibit of the work of the Bureau of Entomology was made during the year for the Louisiana Purchase Exposition—undoubtedly the most extensive and interesting exhibit ever sent out by this Bureau. It contains several entirely novel features of great educational value, and comprises very many cases indicating the life histories of injurious and other insects, together with large models of many of the principal injurious forms and vivaria in which injurious and beneficial insects are shown alive and at work.

SILK CULTURE.

The work in silk culture has been prosecuted in all available lines. Silk reeling has been practically established with imported French reels and the temporary employment of French experts. Several American women have acquired the art of reeling silk, and a beginning has been made in the training of experts in this line of work. The importation of eggs and their distribution to all applicants has been continued; also of mulberry cuttings and rooted plants.

As pointed out in my last report, the establishment of the silk industry in the United States must be a matter of slow accomplishment. The distribution of mulberry cuttings and of silkworm eggs to those

who already have mulberry trees at hand should be continued. Eventually enough mulberry trees will be planted to insure a supply of food for a large crop of worms. Numbers of people will also have become familiar with the methods of silk raising, and conditions will then be ripe for the establishment of commercial filatures. In the meantime and under the existing conditions the establishment of some sort of market for cocoons is necessary; and it is for this reason that this Bureau, out of its appropriations, is buying and reeling a crop of cocoons which, though small at present, will increase as the work progresses from year to year.

BEE CULTURE.

In bee culture comparative tests have been continued with the Caucasian and other types of bees and various crosses between these types themselves, in an effort to improve the domestic hive bee and secure certain varieties of special merit for different regions. The general conclusion reached is that the Caucasian race is by far the gentlest that has ever been brought to this country, and lends itself to manipulation and handling without the use of bee veil, and generally without smoke. These bees also are excellent honey gatherers.

The frequent statements that comb honey can be artificially manufactured have been shown to be absolutely false, and the purchaser who gets his honey in the comb may rest assured that he is getting an article manipulated at least by bees.

A special investigation has been made of bee conditions over a considerable area comprising the Middle West and Western States, with the idea to familiarize the expert with the conditions in these regions and to determine the feasibility and the desirability of the importation and establishment of foreign honey-producing plants.

A model apiary of 50 or 60 colonies of bees has been secured, and it is proposed to establish it on the Arlington Experimental Farm as a basis for apiarian investigations and as a breeding station of races and types of bees. The importation of foreign queens of different races has been continued, and studies have been made of honey-producing plants, methods of wintering bees, and bee diseases.

BIOLOGICAL SURVEY.

As heretofore, the work of the Biological Survey has been conducted along the three lines laid down by Congress: (1) Investigations relating to the geographic distribution of animals and plants, including biological surveys and the determination of the life and crop belts; (2) investigations of the economic relations of birds to agriculture; (3) supervision of matters relating to game preservation and protection and the importation of foreign birds and animals.

GEOGRAPHIC DISTRIBUTION.

The Biological Survey is engaged in mapping the natural life zones and crop belts of the country for the primary purpose of aiding the farmer to decide what crops are likely to prove a commercial success in his locality. The work is done by studying the geographic distri-

bution of native animals and plants in all parts of the country, and platting the results on maps showing the distribution of each species. In order to obtain the necessary data the status of the various species must be determined by office study and their ranges laboriously worked out in the field. The progress already made is gratifying, and a large number of maps are now approaching completion. The individual-species maps serve as the basis of a composite map showing the natural transcontinental belts and their more important subdivisions.

During the current year field work has been carried on over wide areas in California, Texas, New Mexico, Colorado, and Alaska. In California the field operations, for the purpose of securing data for a detailed map of the life and crop zones of the State, have been continued under the personal direction of the Chief. The field parties have practically completed work in western Texas, and are now in New Mexico. Explorations in Alaska have been continued among the northern spurs of the Rocky Mountains, about the upper and middle Yukon, and on some of the islands of southeastern Alaska.

ECONOMIC ORNITHOLOGY.

In the section of economic ornithology, as in previous years, both laboratory work and field observations have been carried on. Orchards, gardens, and grain fields have been visited for the purpose of determining whether the birds damage crops, attack injurious insects, or devote their energies mainly to the wild fruits and weed seeds of the neighborhood; and collections have been made of food materials, including wild fruits, berries, seeds, and insects to assist in the work of determination in the laboratory. During the current year examinations have been made of 2,189 bird stomachs.

In studying the food habits of California birds, with reference both to the damage they inflict upon fruit and the good they do in destroying noxious weeds and insects, a scientist spent seven months (February to October) in the State, interviewing many of the fruit growers and visiting the most important fruit-growing sections. Most of his work was in the orchards, where the actual mischief done by the birds was noted and specimens collected.

In cooperation with the University of California, a study was made of the restrictive influences exercised by birds upon the increase of the well-known and very destructive codling moth. As a result, it was found that the pupæ of the moth are searched out and fed upon to a considerable extent by the black-headed grosbeak (*Zamelodia melanocephala*) and the Bullock oriole (*Icterus bullocki*)—two of the handsomest and commonest song birds of California. Other investigations were made in the same State regarding the supposed injury done by birds to bee keepers. Examinations of many stomachs of birds shot near bee-hives showed in nearly all cases that if bees are eaten at all the ones selected are the males or drones. A careful study of the food habits of the quail or bobwhite made during the year has demonstrated beyond question that from an economic point of view it is one of the most valuable of North American birds. Some of the insect pests eaten by it are the cotton boll weevil, potato bug, chinch bug, wire-worm, cut-worms of various kinds, and the cotton bollworm.

BIRD MIGRATION.

During the year the usual spring and fall migration schedules were sent to and received from the regular observers and filed for future use. Sixteen thousand notes relating to the migration of warblers north of the Ohio and Potomac rivers were selected and arranged to complete a bulletin on North American warblers. This bulletin is now passing through the press. Work was also commenced on a study of the relations of migration and the weather by comparing the time of spring arrivals with the temperature at the place of arrival and in the region to the southward.

GAME PROTECTION AND INTRODUCTION.

ENTRY OF FOREIGN BIRDS AND ANIMALS.

Constant vigilance is necessary to prevent the introduction into the United States of birds or animals that are likely to become pests. No species, therefore, except a few that are well known and harmless, are allowed to enter this country without a special permit from the Department. And, as an additional safeguard, careful inspection is made whenever through the large size of the consignment or other cause there is any apparent danger that undesirable species may slip in. The permits issued during the year numbered 318 and allowed the entry of 1,470 mammals, 205,400 canaries, and 41,630 miscellaneous birds. Most of the canaries and a large part of the miscellaneous birds came in at New York and were examined by inspectors at that port. Several importations were made of birds intended for liberation, among them 65 capercailzie from Sweden, brought in at New York and destined for the stocking of Algonquin Park, Ontario; 40 Mexican quail, liberated at various points in California by the board of fish commissioners of that State; and 366 European song-birds—goldfinches, bullfinches, larks, and robins—turned loose in British Columbia. Permits were also issued for the entry of about 3,000 eggs of partridges and pheasants.

INTERSTATE COMMERCE IN GAME.

Since the passage of the Lacey Act in 1900, 42 convictions for illegal traffic in game have been secured in cases passing through this Department. Of these, 26 were tried in Federal courts, 16 in State courts. During the past year 10 cases, involving the shipment of 700 birds and 36 rabbits, were reported to the Department. Six convictions were secured, one of which involved the longest distance shipment thus far taken up—from St. Paul, Minn., to Portland, Oreg. In order to expedite cases arising under the Lacey Act, State wardens have been advised to present their evidence direct to the Federal courts instead of referring it through this Department and the Department of Justice. This advice has been followed in two or three instances within the past few months, and indictments have been much more promptly secured in consequence.

Limited available resources have, as heretofore, made it necessary to concentrate efforts in two or three areas, and in all cases prevention of shipment has been given precedence over prosecution after

shipment has occurred. The passage of laws by Texas in 1903, prohibiting sale and capture of waterfowl, made it possible for the first time to restrict the enormous destruction of ducks in that State for Northern markets. Through local authorities and express companies general attention was called to the provisions of the State and Federal laws and a close watch maintained on usual shipping routes. No violation of the law was noted, and it is probable few consignments of ducks reached Northern markets from this State during the year.

An attempt was made to ascertain the effectiveness of recent legislation prohibiting shipment and sale of game by means of a special investigation in cooperation with State wardens and others. The kinds and prices of game in the markets of a dozen or more important cities during Thanksgiving week were ascertained. That considerable progress has been made in enforcing shipping laws was conclusively shown; few prairie chickens were on sale in any Eastern markets, and in some instances prices three or four times as high as those of a few years ago were charged; pheasants were absent from the markets of several cities where they were formerly abundant; and at the opening of the season quail were unusually scarce, though later, when the routes of shipment still open were discovered by the trade, they became more abundant.

PROTECTION OF GAME IN ALASKA.

The Alaska game law has accomplished the two main objects for which it was enacted: The shipment of deer hides has been stopped and the export of heads of big game as trophies has been curtailed. The protection of game has been as satisfactory as could be expected in so large a region and without wardens. A mistaken belief, however, that the law does not permit natives to kill game for food, coupled with objections to the presence of visiting sportsmen, particularly on the Kenai Peninsula, gave rise to considerable criticism of the law. This adverse feeling led to the introduction of a bill in the Senate to replace the present law with one doing away with all restrictions except a provision to limit the export of trophies and charge license fees of $25 to residents and $250 to nonresidents for such export. As the adjournment of Congress without definite action left this measure still pending, the Department deemed it advisable to suspend the issue of permits for the present except in very special cases. Early in June new regulations were issued extending some seasons, permitting unrestricted shipment of bearskins, and making other desirable changes.

MISCELLANEOUS WORK.

A preserve for the elk presented to the Government by Miller and Lux was established in Tulare County, Cal., on the Middle Fork of the Kaweah River, just within the boundary of the Sequoia National Park.

On the Pelican Island reservation in Florida a warden has been maintained through the cooperation of the American Ornithologists' Union and the Department, and the pelicans on the island have been practically undisturbed.

As heretofore, special attention has been given to the duty imposed by the Lacey Act of collecting and disseminating information relating to the propagation, uses, and preservation of birds. The demand for

such information is widespread, and much time is devoted to gathering material and preparing it for publication.

RECOMMENDATIONS.

The three distinct lines of work assigned to this Division could be conducted much more economically and effectively were the Division reorganized as a bureau of three divisions, each to have charge of one of these lines, and were a larger amount appropriated for the performance of the work. I have accordingly recommended such reorganization.

BUREAU OF STATISTICS.

On July 1, 1903, the Division of Statistics of this Department, which is the oldest distinctively statistical agency of the Government, antedating by a score of years the creation of this Department, received the broader organization of a bureau.

As now organized the Bureau of Statistics includes a Division of Domestic Crop Reports, a Division of Foreign Markets, and a Miscellaneous Division, which conducts special investigations and collects statistics on rural economics. The work of the Division of Domestic Crop Reports forms the most conspicuous feature of the statistical work of the Department. It employs nearly two-thirds of the entire clerical force of the Bureau, and calls to its aid the public-spirited service of nearly 250,000 voluntary correspondents, whose painstaking service deserves grateful appreciation. The results of its investigations are published monthly in the Crop Reporter, of which over 1,300,000 copies were distributed during the year.

The general appreciation by the business and farming public of the value of the Department crop reports grows steadily. Criticism is not lacking. On the contrary, it is one of the curious features of this work that the more closely reports represent the actual facts and the wider the appreciation of their accuracy the more subject they become to criticism. This is undoubtedly due to the fact that as their general accuracy is more and more widely recognized they necessarily exercise a greater influence upon the markets, thus inevitably favoring or antagonizing, as the case may be, some of those who are engaged in the game of speculation in agricultural products.

This immediately attracts the adverse comments of the losers. This result is unavoidable, and is apparently the inevitable penalty the Department must pay for issuing reports so reliable and so generally appreciated as to have instant effect on the markets. Were the reverse true, and were these reports regarded as unreliable, they would not influence prices, and criticisms would be reduced to a minimum.

The Bureau is earnestly engaged in studying the efforts of numerous associations of cotton manufacturers organized in several European countries for the purpose of promoting the production of cotton in new lands, with a view to rendering them more or less independent of the American cotton grower. These efforts are being especially directed to the interior of Africa. Before long it is thought that the Department will be able to publish some valuable matter on this interesting subject.

The production and international movement of grain in the principal European countries is another subject which is receiving the earnest attention of the Division of Foreign Markets.

With the assistance of experts newly engaged, the rice and truck crops will for the first time be made the subjects of systematic and continuous statistical investigation. The grain belt has been redistricted and an additional field agent assigned to it.

OFFICE OF PUBLIC ROAD INQUIRIES.

Popular interest in road improvement appears to be deeper and more widespread than ever before. This is evidenced by the work of improvement actually going on in nearly all sections, by the State road legislation, by the calls for the road literature issued by the Department, and by requests for the advice and cooperation of the Department in building object-lesson roads.

COOPERATIVE FIELD WORK.

For greater convenience and efficiency in carrying on the field work of the Office of Public Road Inquiries the country has been somewhat roughly laid off into four main divisions, with a special agent in each. The work of these and other special agents in the field consists in collecting and disseminating useful information regarding roads and road building, conducting investigations and experiments, attending and addressing meetings, and representing the Department in cooperative object-lesson road work.

At several points in the South the Office of Public Road Inquiries has cooperated in the construction of experimental roads of a mixture of sand and clay, and the results have shown that, in the absence of stone and gravel, this mixture may often be used to great advantage. Other object-lesson roads were constructed, with the cooperation of the Office, in Arkansas, Ohio, Tennessee, Virginia, and West Virginia. These were in most cases first-class macadam roads. An especial effort has been made to keep accurate accounts of the work done in each case, and to report the operations and expenses in such detail as to make the work a source of instruction to all who may read the reports.

Reports from all sections of the country in which experimental and object-lesson roads have been built in previous years are unanimous in commending the character of the work done and testifying to its great influence for good.

It is intended that the work of the Office shall be continued along the present lines of helpfulness and extended so far as practicable, in order that its benefits may be most widely distributed.

STATE ROAD LEGISLATION.

The most important feature in State road legislation of recent years is to be found in the adoption of the State-aid plan. This plan involves a recognition of the fact that road improvement is a matter of general as well as local interest. The inefficiency of the statute labor system of repairing roads, the unwillingness of the rural taxpayers to assume the heavy burdens necessary to the building of improved highways, the popular aversion to the issuance of bonds, and the lack of any

central authority capable of coordinating the efforts of local communities, have to a great extent paralyzed efforts to secure general improvement of rural highways. The State-aid plan is intended to counteract these depressing influences. It provides sufficient funds to give scope and system to the efforts for road improvement; it distributes the burden of expense so as to greatly relieve the rural taxpayers; and it stimulates action on the part of local communities, coordinates local effort, assures competent supervision, and secures results of permanence and value.

The main features of the State-aid plan as now adopted in a number of the States are (1) a State highway commission, and (2) annual appropriations from the State treasury to pay a fixed part of the expense for building good roads, the balance of the cost to be met by the counties, the towns, and the owners of property lying along the improved roads. In nearly all cases the initiative is with the local communities, and the work is done under local control, but according to plans and specifications which must be approved by the State highway commission.

In New Jersey, the pioneer State in the adoption of this plan, the State pays one-third of the cost and the counties two-thirds, part of the county's share being assessed against the towns, the annual State appropriation being $250,000. In New York the State provides for one-half the expense, while the counties must pay 35 per cent and the towns 15 per cent. In 1903 the legislature appropriated $600,000 as State aid. No two States have adopted exactly the same provisions. Since 1890, eleven States in all have provided for a greater or less degree of State aid. They are the six New England States, New York, New Jersey, Pennsylvania, Delaware, and Maryland. In a number of other States the plan is receiving favorable consideration.

OFFICE OF EXPERIMENT STATIONS.

PROGRESS OF THE EXPERIMENT STATIONS.

The agricultural experiment stations throughout the country are maintaining close relations with this Department and are seeking its cooperation in increasing measure. The Department is endeavoring to aid the stations so far as it can with a view to raising the general level of their work in the directions of scientific accuracy and practical usefulness and to bring the results of their experimental inquiries promptly and effectively to the attention of farmers throughout the United States. It is believed that the Federal funds given to the several States for the maintenance of agricultural experiment stations are now spent more fully for useful agricultural investigations than ever before and that the results obtained by the expenditure of these funds, combined with those contributed by a considerable number of the States, will compare very favorably in scientific thoroughness and practical effectiveness with the results obtained with equal expenditures of public funds for similar work elsewhere.

Under the system of State control of the planning and execution of the experimental operations of the State stations and under the liberal terms of the Hatch Act, through which the States are granted Federal funds for the partial maintenance of their stations, there is necessarily considerable diversity of opinion as regards the proper and wise

expenditure of these funds. This fact is often overlooked in criticisms of the work of our stations as related to their use of public funds. With the growth of intelligent public opinion in the several States regarding the most useful functions of the experiment stations, the grade of their work has been raised, and when once the local constituency of a station has understood the real purpose and importance of good agricultural investigations, there has been little difficulty in securing the adherence of the managers of that station to the spirit as well as the letter of the laws under which the station is conducted.

ADVICE AND COOPERATION FROM THE DEPARTMENT.

It has been the effort of this Department to set before the stations a high standard of efficiency and to exert steady pressure for the improvement of their work. The cases of clear departure from the law in the use of the public funds granted under the Hatch Act have been comparatively few, and in such cases this Department has insisted on such an adjustment of expenditures as would protect the Federal funds. In most instances of this kind the stations have had funds wholly subject to State authority which could be spent more freely than the Federal funds and so have easily adjusted their accounts to meet the requirements of the Hatch Act. In some cases this has not been practicable and loss of a portion of the Federal fund of the ensuing year has resulted. Not a year passes but that some stations are persuaded by this Department to forego expenditures of the Federal funds which under the terms of the Hatch Act they might technically insist they had a legal right to make but which after discussion they are convinced are not in the best interests of their work. Especially has there been effected a more liberal interpretation of the duties and responsibilities of the agricultural colleges toward the stations, which are organized as departments of research in these institutions. There are now only a few of these colleges where the narrow and short-sighted policy of dealing illiberally with the experiment stations is maintained, and this Department will not cease its efforts to bring about a change of view and action by such college authorities on this important matter.

As the amount and variety of the cooperation between the bureaus of this Department and the State experiment stations increase there arise from time to time questions of policy regarding the relations of the Department and the stations in such enterprises. To provide a regular agency for the discussion and adjustment of such matters, I have created during the past year a standing committee on cooperation, consisting of the Director of the Office of Experiment Stations and the Chiefs of the Bureaus of Plant Industry and Soils. Several conferences have already taken place between this committee and the executive committee of the Association of American Agricultural Colleges and Experiment Stations.

During the past year a movement looking to the increase of the funds granted by Congress for the use of the experiment stations has been inaugurated and legislation for this purpose is now pending. After a careful study of this matter in connection with the examination of the work and expenditures of the stations during the past two years, I am convinced that the demands on the stations for the extension of their work which have been aroused by their success in giving direct practical benefits to agriculture in all parts of the country can

not be met without increased funds and that they are in a position to make effective use of larger means than they now have at their command. Now that this matter is being publicly discussed and the details of legislation have not been decided, it seems proper to state that in the view of this Department it is highly important that in any further act which Congress may pass for the benefit of the agricultural experiment stations the Federal funds shall be explicitly granted for purposes of agricultural research, and the powers and duties of this Department as related to the supervision of those funds shall be clearly defined.

STUDIES IN CHEESE MAKING.

As the work of the experiment stations advances from year to year experimental data accumulate in many lines, and from time to time results of great general importance come out of this extensive work. A good example of this at the present time is found in the investigations of the stations relating to cheese making. The importance of this in this country is shown by the fact that cheese production now amounts to 300,000,000 pounds a year, valued at approximately $30,000,000. Though cheese making is probably the oldest dairy industry, very little has been known regarding the principles on which it is based. For centuries it has been carried on largely by rule-of-thumb methods, and the reasons for the various processes and the exact nature of the changes brought about by them have been unknown to the cheese maker. He has been guided mainly by the traditions of his art and has depended upon the skill and judgment acquired through long experience.

Within the past ten years several of the experiment stations of this country have prosecuted systematic studies of cheese making with a view of determining the principles upon which it rests and the means of simplifying and improving its processes. Owing to the large number of factors involved the work has been difficult, and for a considerable time the progress was slow. Now, however, the accumulated results are of great practical value, and it may be fairly claimed not only that this great industry has been put on a rational basis, but also that the art of cheese making has been simplified and its processes can now be more easily controlled, so that good cheese can be more uniformly produced.

GAINS IN USE OF FEEDING STUFFS.

The Office of Experiment Stations has recently published a summary of a large amount of work which the stations have done on questions relating to feeding stuffs. Some of the practical results of this work have been very important. The saving and use of corn fodder (stover), which was formerly so largely wasted over a large part of the country, is a striking illustration of this. Its value as a feeding stuff has been demonstrated, and the best means of utilizing it have been shown by the stations' work, and their continual agitation has brought about very great improvement in farm practice in this respect. At the nominal value of $1 a ton the corn stover crop of the United States would be worth at least $100,000,000. While it is not all utilized, much the larger share of it is, and the practice of doing this is steadily increasing.

The inspection of commercial and condimental feeding stuffs, brought about by the experiment stations, has already had the effect of largely holding in check the adulteration of these products and fraud in their sale. In a number of the States where the laws have been vigorously enforced by the stations inferior articles have been entirely driven out of the market, because farmers would not buy them unless they received the stations' stamp of approval.

THE AGRICULTURAL COLLEGES.

The activity of the colleges in providing special buildings and laboratories for instruction in the different divisions of the science of agriculture continues unabated. Among the buildings of this nature recently completed are the $50,000 agricultural building in South Carolina, the $150,000 agricultural building of the University of Wisconsin, and the agronomy and animal husbandry judging pavilion and the farm mechanics building of the Iowa State College of Agriculture and the Mechanic Arts. The University of Nebraska is erecting a $60,000 building for its school of agriculture.

The appropriations of the year for new buildings at the colleges and for the maintenance of these institutions have also been very large. The State legislature of Virginia appropriated $165,000 for buildings, equipment, and improvements at the agricultural college. The Iowa college has an addition of $50,000 to its maintenance fund, an appropriation of $95,000 to complete the central building, $45,000 for a dairy building, and $10,000 for equipping it, $22,000 for a new dairy farm, and $7,000 for equipment, and $54,500 to begin the construction of a heating plant, with several minor items, including $15,000 annually for the experiment station. The College of Agriculture of Cornell University is now definitely organized under State support, with an appropriation of $250,000 for buildings and equipment. The Illinois College of Agriculture has appropriations for a building for beef cattle, $25,000; another for horticulture, $12,200, and for a storage building for agronomy, $12,500. Minnesota has appropriations aggregating $300,000 for building purposes, including, among other items, $218,000 for a main agricultural building.

There is increasing interest in the formulation of courses in rural engineering and the provision of special facilities for instruction in this important subject. Special attention is being given to instruction relating to the construction and use of farm machinery. The continued scarcity of farm labor in almost all of the agricultural regions in this country makes necessary the employment of farm machinery on even a more extensive scale than has hitherto prevailed. The total value of implements and machinery on farms in this country, according to the last census, was $761,261,500, an average of $133 per farm and of 90 cents per acre of farm land. Much of this machinery is elaborate and complicated in construction and requires mechanical skill and genius for its most efficient operation and care. In very many cases it is also essential that the farmer shall understand how to repair such machinery. It represents an important part of the farmer's invested capital upon which he must earn or pay interest. That there is an enormous waste of money due to neglect and unskillful handling of this part of the farm equipment must be obvious to any

one who has traveled through the regions where it is most used. The colleges can therefore do a very important work in training their students so that they will understand the construction, care, and most economical use of farm machinery.

The attendance at the land-grant colleges in 1903 aggregated 52,489 students, of whom 3,146 were in four-year courses in agriculture, and 7,550 in shorter courses in agriculture, dairying, horticulture, and veterinary science. The graduates of these institutions in 1903 were 4,524, and since their organization 53,252. The importance of the colleges of agriculture and mechanic arts as a part of the American system of higher education and research has been notably shown during the past year at the Louisiana Purchase Exposition, where an extensive exhibit of the work of these institutions was made in the Palace of Education.

SECONDARY AND ELEMENTARY SCHOOLS.

Progress has been made during the year along the lines of secondary instruction in agriculture not only in the schools maintained in connection with the agricultural colleges, but also in separate secondary schools, the number of which is steadily increasing. Considerable attention is being given of late to the practical instruction of women along agricultural and horticultural lines.

The introduction of agricultural instruction into the primary schools is being more widely discussed than ever before at meetings of teachers and farmers. The success of the nature study and school garden movement in a considerable number of city and country schools has led to a demand for the more formal teaching of elementary agriculture in the higher grades of the rural schools. The National Educational Association, State superintendents of public instruction, officers of agricultural colleges, as well as a number of other organizations and numerous individuals in various official positions, have of late interested themselves in the introduction of elementary agriculture and gardening in these schools. The National Educational Association now has a special committee of educators of national repute considering this subject.

METHODS AND TEXT-BOOKS.

At the recent convention of the Association of American Agricultural Colleges and Experiment Stations at Des Moines, Iowa, the standing committee on methods of teaching agriculture made a report in which it gave a brief history of the development of manual training and agricultural instruction in the common schools, and outlined a course of nature study and elementary agriculture for such schools. Outline courses in elementary agriculture have already been prepared by school officers in a number of States. These are supplemented by the formation of clubs of farmers' boys and girls, which are organized for the purpose of conducting simple experiments at their homes. Eight thousand Illinois boys belonging to these clubs exhibited corn of their own raising at the Louisiana Purchase Exposition. In a number of States laws have been enacted requiring teachers to pass examinations in agriculture, and the training of teachers along agricultural lines is already receiving considerable attention at agricultural colleges and schools, and normal schools, especially at sessions held

during the summer. A considerable impetus to the movement for the introduction of agriculture in the public schools has been given by the recent improvement of text-books and works of reference. Within the last year or two a number of elementary text-books in agriculture have been published, and some of these seem well suited to use in the rural schools. In one way or another thousands of children in the common schools are already receiving some instruction relating to agriculture, and the movement in this direction is rapidly increasing.

AID FROM THE DEPARTMENT.

This Department is aiding this movement so far as it can without having funds specifically for this purpose. It seems very desirable that the Department should be in a position to give more effective aid to the movement which contemplates the application of the results of practical and scientific investigations to our agriculture through instruction to multitudes of farmers' children in the public schools as well as in the agricultural colleges. The vast majority of teachers in rural schools throughout the country are unacquainted with the work and publications of this Department and do not understand how these publications might be utilized for instruction in subjects related to agriculture. Very much needs to be done to overcome the prejudice of school officers and teachers against the introduction of agricultural subjects into the schools. It is becoming increasingly clear that the results of the work of this Department and the experiment stations can not be most effectively and widely utilized by our farmers unless in early life they are taught to think and act along the lines in which the application of scientific principles and discoveries is made to appear theoretically rational as well as practically useful. Therefore, to secure the greatest benefit to our agricultural people through the expenditure of public funds in the maintenance of this Department and the experiment stations, we should be able to bring the work of these institutions directly to the attention of our educators and school managers in every State and Territory.

FARMERS' INSTITUTES.

Work in the interests of the farmers' institutes throughout the country has been regularly organized in the Office of Experiment Stations. Special efforts are being made to aid the large force of lecturers who are in the employ of the State directors of institutes. The attention of these lecturers has been definitely called to the numerous publications which this Department and the experiment stations are issuing, which will be useful to them in their institute work, and they have been put in the way of receiving these publications regularly.

There is also a growing movement for the establishment of the institutes in the several States on a more permanent basis. The form of organization most approved is that of a strong local permanent organization in each institute district, combined with a system of oversight and limited control by the central State authority, whose duties and powers are prescribed by law.

ALASKA EXPERIMENT STATIONS.

During the past year experiment stations were maintained at Sitka, Kenai, Rampart, and Copper Center, and cooperative experiments were

conducted at Wood Island. Seeds of vegetables and flowers were distributed through the cooperation of the Bureau of Plant Industry to about 1,500 addresses. Many of the recipients report success and further confirm the possibility of raising hardy vegetables and hardy annual flowers in nearly all parts of the Territory south of the Arctic Circle. An investigation of the grasses and forage plants of Alaska is being conducted in connection with the Bureau of Plant Industry. At Sitka the headquarters building has been completed in accordance with the plans furnished by this Department, except for some minor alterations made in the interests of economy. More attention will hereafter be given at this station to horticulture and the propagation of trees and bushes for distribution to the other stations and over the Territory at large. Some nursery stock consisting of hardy and early maturing varieties of apples, plums, and cherries have been planted, and currants, gooseberries, and raspberries are also being propagated.

SOME RESULTS OF THE WORK AT THE STATIONS.

At the Kenai station about 21 acres have been brought under cultivation. Experience during the past two seasons at this point has shown that the maturing of grain is somewhat uncertain, though an abundance of forage can be grown every year. Cattle do well here, and the station is beginning in a small way to build up a herd.

At the Copper River Valley station, opened two years ago, a number of acres have been cleared and cultivated. During the season of 1903 barley and oats matured, and produced plump and heavy grain. Cultivated grasses seeded in experimental plats did well, and a considerable variety of hardy vegetables were grown. In 1904 an elaborate system of plants has been laid out and extensive experiments are under way with cereals. During August a severe frost destroyed many varieties of the cereals, rendering them fit only for hay, but some barley was matured and the grain saved for seed, and about 90 per cent of the Sixty Day and Finnish Black oats were matured, making about an average crop. This station has the first equipment of farm implements brought into the interior of Alaska. A number of small tracts have been cleared by settlers and are under cultivation at various points throughout the valley.

At the Rampart station grain matured in 1902 and 1903, and for this reason more extensive experiments have been conducted during the past year, and barley, oats, and rye have been successfully grown.

In general the experimental work in Alaska has shown that live stock may be successfully maintained at many points in the Territory. The special agent in charge of the Alaska stations urges the desirability of securing breeds of sheep and cattle better adapted to the climate of Alaska than those which have hitherto been maintained there. It is, however, impracticable to carry on experiments with animals in any large way with the present funds at the disposal of the stations.

GRASS LANDS AND LIVE STOCK.

There are on the southern coast of Alaska, from Cook Inlet to Unalaska, about 10,000 square miles of grass lands, over one-half of which are capable of utilization. On much of this land there is a luxuriant growth of grasses often 6 feet high; on the remainder, lying at

higher elevations and in more exposed situations, the grasses are too short for hay cutting, but furnish splendid pasturage. That these grasses are nutritious the fat and sleek condition of the cattle furnishes ocular demonstration.

At the present time this great resource is practically untouched, though there are small herds of milch cows at most of the towns and villages. Recently a live-stock company has begun operations with cattle and sheep on Kodiak Island and another company is making actual preparations to utilize Akutan Island.

It is possible for both sheep and cattle to live throughout the winter without care, as has often been demonstrated. Indeed, where cows belong to the natives they are forced to live through the winter with little or no care, eking out an existence by feeding on browse and seaweeds. Milch cows kept by whites are as a rule fed from five to six months, and this may fairly be considered the length of time when animals require feed and shelter.

Sheep raising has thus far not proved successful. The principal trouble seems to have been that the animals were of breeds not adapted to the conditions that prevail on the Alaska coast. In both cases where trials have been made grade animals were imported from the semiarid regions of California and Oregon, where the climate is well-nigh the antithesis of that in Alaska. With other breeds success is not at all unlikely to follow.

For three reasons I am impelled to believe that the Alaska grass lands as a whole can be most profitably utilized at present through dairying. First, because the small population of the Alaska coast limits the market for beef to a small fraction of the possible yield. Second, because of the necessarily long feeding period, five or six months, during which only dairy cattle will yield compensating returns. Third, because the freight to distant markets on concentrated products like butter and cheese is not a serious factor.

The Alaska coast furnishes many admirable sites for dairy colonies or settlements, both on the islands and on the mainland. With such a great wealth of grass as southwestern Alaska possesses it is difficult to believe that it will not become a great dairy country. It is doubtful if equally good opportunities for colonies of dairymen can be found in the United States to-day. Certainly there is no other place left where 320-acre homesteads of magnificent grass lands can be had for the taking. In view of the enormous area of these lands, it seems most advisable that this undeveloped resource be converted into wealth. Perhaps nothing will stimulate this as much as practical experiments and demonstrations by the Department of Agriculture.

HAWAII EXPERIMENT STATION.

A chemist and horticulturist have been added to the staff of the Hawaii station, and in this way the field of operations has been considerably widened. Soil investigations have been undertaken by the chemist, which are of general importance to the agriculture of the islands. The horticulturist has prepared a bulletin on bananas, which not only treats of the cultivation and marketing of this fruit, but also brings together descriptions of a large number of Hawaiian varieties, making possible a systematic study of this important food plant. Experiments are being continued on the cultivation and fertilization of

bananas, and a large collection of varieties is being brought together on the station grounds. Experiments in the propagation of mangoes and alligator pears have been begun.

The entomologist has prepared a bulletin on the leaf hopper of sugar cane, which was investigated at the solicitation of many of the planters of the islands. This insect made its appearance quite recently and has proved in certain districts to be a very serious enemy to cane cultivation. The bulletin treats of the life history of the pest, describes the injury produced, and offers suggestions for its control.

Under the immediate direction of the special agent in charge, investigations have been made of some of the fungous diseases of coffee, sugar cane, and other economic plants, and a comparative test of grasses and forage plants has been begun in connection with the Hawaii Live Stock Breeders' Association. Cooperative experiments with tobacco have been conducted on the island of Hawaii with the object of producing a type of tobacco that is especially adapted to Hawaiian conditions. Cooperative experiments on cacao and banana cultivation are also being carried on in connection with the insular board of agriculture and the Hilo boarding school.

PORTO RICO EXPERIMENT STATION.

The work of the Porto Rico experiment station has been considerably enlarged during the past year, partly with the aid of an appropriation of $2,700 made by the insular legislature and nearly $1,200 received from the sale of farm products.

Many permanent improvements have been made on the station farm. A small tile machine was purchased and drain pipes were manufactured on the farm. Practically all the river bottom or alluvial land on the station farm has been drained. This is the first underdrainage ever undertaken in Porto Rico, and it is believed that it will not only greatly enhance the producing power of the station property, but will also serve as a valuable object lesson to the planters of the island. An experimental irrigation system has also been installed on this farm.

A preliminary survey of the principal tobacco districts of the island has been made by a tobacco specialist in the employ of the station, and a report on these investigations is being prepared.

The investigations on different methods of pruning, shading, and fertilizing coffee plants have been continued. An attempt to exterminate the coffee-leaf miner by hand picking the leaves proved the impracticability of this method of repressing this pest. The entomologist of the station has also been investigating the possibility of combating this insect by means of parasites, and reports the discovery of an effective parasite which, it is believed, by careful propagation and distribution, will aid very materially in keeping in check this insect, which is by far the most serious enemy to coffee cultivation now upon the island.

A special study of the diseases of coffee and other plants was made by the botanist of the Connecticut State experiment station, who was temporarily in the employ of the Porto Rico station.

Much attention is being given to the propagation of citrous fruits, especially with a view of obtaining better stock for growing in the orchards of Porto Rico. A bulletin on the methods of production and

marketing of oranges, with special reference to Porto Rico conditions, has recently been issued. A large number of tropical fruits, including mango, alligator pear, soursop, nispero, guava, and many others, have been brought together in a tropical fruit orchard.

The tea, rubber, and cacao plantations mentioned in my last report are flourishing and are being extended. Among the tropical vegetables which enter into the variety tests are the yautia, taro, edible canna, arrowroot, cassava, yams, and sweet potatoes, all of which have thus far done well.

Experiments are being carried on with a number of fiber plants. Among these, maguey and sisal have thus far given very promising results. The station has thus far conducted no careful experiments with cotton, but the industry has been extended throughout the island to a considerable extent during the past year, and the station officers report that the results seem to indicate that it is possible to profitably produce a medium grade of Sea Island cotton in Porto Rico.

The report of the Bureau of Soils on the soil survey from Arecibo to Ponce, made by that Bureau in cooperation with the Porto Rico station, has been reprinted in both English and Spanish for distribution on the island. Several other bulletins and circulars in both languages have been issued during the year.

PROPOSED EXPERIMENT STATION AT GUAM.

This Department has recently received a request from the governor of Guam for the establishment of an agricultural experiment station on that island. In making this request the governor states that the population of the island, consisting of about 11,000 people, and increasing at the rate of about 3 per cent a year since the American occupation, is devoted entirely to agriculture. The farms, which are small, are located in the hills back of the surrounding towns, and the people usually go to them in the early morning, returning to their domiciles at night. As they are devoted to tilling the ground and the raising of fruits, and to nothing else, this is an especially good field for the introduction of such additional fruits and vegetables as only the resources of the Government can command. The revenues of the island are insignificant, so that the people can not afford to pay anything toward an experiment station, although its influence will be very beneficial. There is a considerable tract in the public lands of the island which could be set aside for an experimental farm.

Since it seems quite important that the people of Guam should receive such aid in developing their agriculture as is now given by the Government to our other island possessions, I have recommended an appropriation of $5,000 for the maintenance of a station on this island in cooperation with the Navy Department.

NUTRITION INVESTIGATIONS.

In the nutrition investigations steady progress has been made in the elaborate and fundamental inquiries regarding the laws of human nutrition with the respiration calorimeter, and in the more directly practical studies of the nutritive value of cereals, fruits, and meat. The great importance of these investigations is being recognized, not only by scientific and educational institutions throughout this country,

but also in many foreign countries. The constantly increasing number of requests for nutrition publications and for information from individuals, institutions, public schools, medical schools, and similar sources, is a proof that the results of the nutrition investigations excite wide interest and are appreciated.

The cooperative method by which the work of investigation has been distributed among various educational, scientific, and similar institutions in the United States has been productive of as excellent results the past year as hitherto, and a satisfactory amount of investigation has been conducted. This has been made possible in part by the generous support accorded by the cooperating institutions, which have contributed in some cases money, and in practically all cases the use of laboratories, apparatus, libraries, the advice and counsel of skilled experts, and similar assistance. Other institutions have expressed a readiness to join in such researches, provided a comparatively small amount can be allotted them, but with the funds at our command it has not been found possible to extend the inquiry beyond the present limits.

CALORIMETER EXPERIMENTS.

The experiments with the respiration calorimeter during the past year have had to do principally with the comparative values of fat and carbohydrates as sources of energy. The apparatus has been so modified that a given quantity of air is circulated through the respiration chamber, the oxygen withdrawn by the subject being made good by the addition of a fresh supply, while the products of respiration are removed for measurement and analysis. This method of experimenting permits of direct measurements of the oxygen consumption in addition to other factors concerned with the metabolism of matter and energy, and represents a decided advance. In its present form the apparatus is fully as accurate as the form previously described and gives very satisfactory results. The form of apparatus which may be most advantageously used depends upon the character of the problem which is to be studied, since both the earlier type, in which a continuous quantity of air was pumped through the apparatus, and the present type, with the closed air circuit, furnish very accurate means of studying a large variety of problems which have to do with the fundamental laws of nutrition and practical questions connected with the satisfactory feeding of man and domestic animals.

SPECIAL STUDIES OF THE YEAR.

During the year the experimental and editorial work connected with the dietary studies at the Government Hospital for the Insane has been completed and a bulletin describing the results in detail has just been published. The data secured are of great interest in themselves and will prove of material assistance in formulating dietary standards and in other ways, while the experience gained in conducting investigations will prove of great value in future work of a similar character. The studies showed that the diet at the Government hospital was well managed and that the food was abundant, of good quality, and well prepared. As the study progressed it became evident that in many ways economy in the preparation, handling, and storing of food might be introduced which would prevent waste and effect a considerable saving without making any radical change in the character

of the menu. In other words, it was evident that, as in all business enterprises, more careful and expert management would prove valuable.

The studies concerned with the nutritive value and digestibility of flours of different grades have furnished very interesting data and the material now accumulated seems sufficient for answering the much-discussed question as to the comparative value of different sorts of flour ground from a given lot of wheat. It seems fair to say that the grades of flour known as whole wheat and graham contain a somewhat larger proportion of protein and ash than the patent grades, but are inferior as regards the thoroughness with which they are digested. Judging, therefore, by the total material which the body receives, the various sorts of flour are practically equal in value. The mechanical effect which the coarser flours exercise on the digestive tract should not be overlooked.

The dietary studies and digestion experiments with Maine lumbermen have given some interesting and valuable results. In fixing upon dietary standards it was desirable to have data regarding the kinds and amounts of food consumed by persons performing severe work and leading a very active outdoor life. Such conditions were met in the Maine woods. The diet with which the lumbermen were provided was comparatively simple in character though generous in amount. Generally speaking, the quantities eaten were fairly large, furnishing an abundance of both protein and energy. The food was quite thoroughly digested, no difference being observed between these men and those living and working under more usual conditions.

At the University of California, the investigations concerning the nutritive value, digestibility, and place in the diet of fruits and nuts have been continued and important data are being accumulated. The bulletins already published, which report the results of these investigations, have been widely circulated, showing that there is a popular demand for information along these lines. A popular bulletin has been published showing how a surplus fruit supply may be used in the household for the preparation of jams, jellies, and similar products, a class of foods which may be made to supply carbohydrate material in a palatable and attractive form, while at the same time the acids and other bodies which the fruits contain are believed to exercise a beneficial effect on the system.

IRRIGATION AND DRAINAGE INVESTIGATIONS.

METHODS AND PROBLEMS.

During the past year the office of Irrigation and Drainage Investigations made a comprehensive study of the methods and cost of preparing land for irrigation. The results show the need of a better understanding of this subject by farmers. Much has been done by the Government and the States to aid engineers in the right planning of dams and canals, but farmers have not been aided in like measure in understanding how to get the best results out of the water when furnished. A bulletin published by the Department gives descriptions and illustrations of the tools used in grading land and building laterals and of the leading systems in use in distributing water in fields, orchards, and gardens. These studies show that the cost of preparing land for irrigation is far greater than has been realized, varying under

flooding from $2 to $5 an acre and under the check system from $8 to $25 an acre. Here is a large opportunity for saving money to farmers by aiding them in choosing the method best suited to their conditions.

Last year a working agreement was entered into with the Western experiment stations for the systematic collection of information on important features of irrigation practice, which will enable this Department promptly and at small cost to collect and disseminate information of great practical value. This year the subjects studied were the methods of measuring water, the rate of rise of soil water during the irrigation period, and the use of cement and concrete instead of wood in irrigation structures.

DUTY OF WATER AND APPLICATION TO SOIL.

The increasing value of water has given added importance to the studies of its duty, which have been a leading feature of this investigation from the outset. Rights which originally were purchased for $5 an acre now sell for $35 an acre. Annual water rentals have risen in certain districts from $1 to $7 an acre. Every extravagant appropriation of water is a direct incentive to waste, and excess contracts and decrees will continue to be made so long as the quantity actually used has not been determined by accurate impartial measurements. This fact is giving the work of the Department increasing importance. Its reports are being used in fixing water-right decrees, and measurements of the duty of water on streams where adjudications are proposed, are urgently requested.

Scarcity of water in the arid West makes it desirable that it shall be used by irrigators in the most economical and skillful way. To aid in making this possible the Department is carrying on a series of scientific studies to determine the quantity of water which will give the best results and the best method of applying it to crops. In one important irrigated district these measurements show that the quantity needed to irrigate 60 acres of land under the method in common use will irrigate 100 acres when applied by another equally feasible method. They also show that the time of irrigation and the quantity of water used have an important influence on the quality as well as on the yield of crops.

PUMPING WATER FOR CROPS.

During the past season records of the performance of over 2,000 irrigating pumping plants, scattered from Texas to Washington, have been obtained. These included many types of pumps operated by gasoline, crude oil, distillate, by steam generated by means of oil, coal, and wood, by electric motors, windmills, and water power. The rapid extension of pumping as a means of extending irrigation gives great practical importance to these studies.

Wind is one of the neglected but promising sources of power for providing water for irrigation and for doing other farm work. An arrangement has been made with the department of farm mechanics in the Iowa State College to supplement the field studies made during the year by more careful tests of the efficiency of different makes of windmills. The makers of these machines have manifested much interest in these investigations and have not only offered to supply

the mills needed for testing free of cost but to manufacture others according to any special design suggested by this Department.

Last season's pumping studies lead to the conclusion that there is a broad field for irrigation by pumping; that where the lift of water is less than 50 feet the number of failures are comparatively few. The failures noted have been due to two principal causes: Lack of mechanical knowledge or skill on the part of farmers needed to keep machinery in proper condition; and the selection of pumps of too great or too small capacity for the work to be done.

IRRIGATION IN THE HUMID SECTIONS OF THE UNITED STATES.

The studies of irrigation in Italy show that irrigation is highly profitable in a region having a larger rainfall than the Mississippi Valley, and there seems no doubt that in a similar way it is to have a large field of usefulness in the eastern and southern portions of the United States. One of the special crops which require irrigation is cranberries, and a cooperative arrangement has been made with the experiment station of Wisconsin and the Wisconsin Cranberry Growers' Association, under which the Department is attempting to formulate the principles which should govern the irrigation and drainage of cranberry beds. The studies made in Wisconsin are being supplemented by similar studies in New Jersey.

In the rice districts of Louisiana and Texas practically all the water used in irrigation has to be pumped. The quantity used and the performance of different types of pumps in providing it are controlling factors in the success of this industry. Both these have been studied during the past year.

There is a large territory in central Arkansas which is believed to be well suited to rice growing. The Department is cooperating with the State experiment station to ascertain whether it will pay in this section to pump water to irrigate rice. The results this year, while encouraging, show that it will require considerable experimental work to place the industry on an assured basis.

DRAINAGE INVESTIGATIONS.

Crop production is being extended in this country in three ways—(1) by reclaiming, through irrigation and drainage, lands hitherto worthless or yielding only a nominal return; (2) by improving soil conditions in lands already under cultivation; (3) by scientific rotation and intensive cultivation of crops.

Since soil drainage is an important factor in all of these, the promotion of practical and efficient methods may do much for the general improvement of agriculture. Original investigation, combined with careful scrutiny of current practice in this and other countries, will enable this Department to place before State and district authorities, cultivators, and landowners the methods and practices suited to their conditions.

The following work was carried on during the year:

(1) An examination of some of the irrigated lands of Utah for which drainage is urgently needed, the giving of advice concerning plans, and the beginning of some experiments in tile drainage to determine the operation of underdrains in certain soils.

(2) The examination of several large drainage projects in the Middle West, in company with engineers, county boards, and interested land-

owners, followed by reports and recommendations of plans. About 400,000 acres of land are affected by these projects, with an estimated outlay for drainage of $1,000,000.

(3) Collecting and classifying field data upon the construction of levees for protection of river bottom lands; their ditching and drainage by pumps; construction, duty, and operation of land dredges; the construction and behavior of drainage ditches of various sizes.

(4) Collection of data regarding the operation of the older systems of tile drainage in the Middle West, with respect to determining how far conditions may be improved by reconstruction.

A preliminary examination of a portion of the Everglades in Dade County, Fla., was made in conjunction with the Bureau of Plant Industry, and it is thought that the Everglade soil can be made profitable for growing subtropical fruits if it can be sufficiently drained. In view of the interest taken in growing fruit and vegetables in southern Florida for the Northern winter markets, the reclamation of the Everglades merits further attention.

The lines of work carried on during the present year indicate the widening importance of this branch of agricultural improvement. The condition of much of the farming land in the older irrigated districts, and especially in Utah, demands prompt and active relief through drainage, or the loss already suffered by bogging of the land will be rapidly augmented. The Department can render great assistance to the people of these sections by enabling experts to direct and assist in starting practical drainage operations in localities where farmers are ready to begin.

An entirely different class of problems has been encountered in connection with the drainage of the peat swamp lands of central Wisconsin. Here the assistance of the experts of the Department has been requested in order to determine the manner in which drainage should be accomplished and regulated during the subsequent treatment of these marshes.

The reclamation of tidal marshes is a subject upon which numerous inquiries have been received and which may be profitably studied.

The further development of the prairie lands of Arkansas and the heavy cotton lands of Mississippi will depend upon the introduction of more thorough methods of drainage. There is no public information available bearing directly on the treatment of the drainage problems there encountered, although it is a fundamental matter in the development of certain lands in these States.

The drainage experts of the Department have given considerable time and thought in advising with and aiding agricultural colleges and stations about courses of instruction in drainage engineering and the carrying out of experiments in drainage. The establishment of these courses of study and the special training of men to carry out this branch of farm improvement promise much for the betterment of soil conditions and soil production in future years. The success of these classes is shown by the fact that Illinois has 42 and Iowa 65 students at present enrolled in drainage engineering.

AGRICULTURAL ENGINEERING.

The valuable results which have come from including irrigation and drainage in the work of the Department leads me to believe that this

investigation should include two other branches of agricultural engineering with which they have a close relation. These are farm buildings and farm machinery.

That this Department should give some attention to the convenience and healthfulness of farmhouses and farm buildings would not seem to require any argument. These have such vital relation to the attractiveness and profits of farming and to the improvement of the social and industrial conditions of farm life that they ought not to be ignored by this Department.

There is urgent need of study of the important question of ventilation and lighting in farm barns. A recent investigation carried on by the Agricultural College of Wisconsin has shown that scores of costly barns, intended to house valuable blooded live stock, and on which thousands of dollars have been expended to secure perfect sanitary conditions, are a complete failure so far as ventilation is concerned; and that this lack of proper ventilation is causing serious increase in the spread of tuberculosis and seriously impairs the profits of feeding. Hundreds of farmers are delaying the building of barns because, while they realize the nature of the difficulty and the necessity for its remedy, they do not know how to accomplish it. It is a striking but admitted fact that we are so ignorant of the proper principles of barn ventilation that many of the costliest structures built in recent years have been the most defective in this regard.

There is another reason for this Department giving some attention to the subject of farm buildings. We are entering a transition period in which the cheap wood construction of former years is giving way to permanent structures of stone, concrete, and iron. Farm houses, through better water supplies, plumbing, and sanitation, are being made as convenient as those of the city. The working out of these changes involves so many new problems that the Department is being called upon by experiment stations, improvement associations, and communities for advice and information which if furnished could not but result in a marked improvement in the conditions of farm life.

MACHINERY AND MOTIVE POWER.

Closely related to the healthfulness, convenience, and cheapness of farm buildings is the right selection, care, and use of farm machinery. The studies of pumping machinery have shown that the most important factor in its successful use is the mechanical skill of the farmer, and we are beginning to understand that the increased complexity and cost of farm machinery make the education of the American farmer along these lines more and more desirable.

No more significant change is taking place in American agriculture than the extent to which different kinds of motive power are taking the place of men and animals. The use of the traction engine and automobile in the place of the horse on the country roads, the employment of gasoline, steam, wind, and electric power to operate mowers, threshers, plows, feed cutters, corn huskers, and dairy machinery are illustrations of epoch-making changes that are now going on on every modern American farm. On one ranch in California there is $60,000 worth of farm machinery operated by some other power than animals or man. For want of proper information these changes are involving farmers in serious mistakes and large losses. They buy motors not

suited to their requirements or which they do not know how to operate. They buy machinery not adapted to their condition and cause its rapid destruction by not knowing how to care for it.

There is made and sold each year in this country about $100,000,000 worth of farm machinery. Fully one-half of this goes into the hands of men who do not know how to select it wisely or to keep it in proper condition. The waste which results runs into millions of dollars annually. In addition, implement manufacturers lose large sums in making and attempting to introduce machinery unsuited to the work it is intended to perform, with a resultant loss to both farmers and manufacturers.

Realizing the need of improvement in these matters, and partly to meet the requests of implement manufacturers for young men having agricultural and mechanical training which will enable them to design and construct implements suited to the conditions of the American farm, a number of agricultural colleges and experiment stations have inaugurated courses of instruction and begun systematic experimentation for the purpose of bringing about a general diffusion of intelligence about this feature of farm work. They have appealed to this Department for aid in this work similar to that already given them in other lines of agricultural investigation.

TESTS OF CORN PLANTERS AND WINDMILLS.

As illustrating the important results which are destined to come from the inauguration of this work, one of the results of an investigation carried out by the Iowa State College, a pioneer in this line of education and experimentation, will be given. It began its study of farm machinery with the operation of corn planters, because no single factor contributes more to the yield than securing a uniform stand, and this is impossible if the seed is not planted evenly. The machines for planting corn in hills are intended to drop from three to four grains, yet farmers have been buying, and implement makers manufacturing and selling, planters without any definite knowledge as to how they behave in this respect. In making this test all of the leading machines were included. It brought out the following significant facts:

(1) That no planter now made will drop evenly unless the grains have been graded. The introduction of seed-grain graders followed, and was an immediate, important, practical gain to agriculture and to manufacturers of this kind of machinery.

(2) That with graded grain certain types of machines do accurate work.

(3) That other types will not drop evenly under any conditions.

The important and encouraging feature of this investigation has been the interest shown by manufacturers who have accepted the results as impartial and conclusive. Makers of machines found defective were as ready to accept the results as the makers of those which operated properly, the defects being at once corrected.

The test of windmills by the Iowa State College to determine the designs and sizes best suited to lifting water for irrigation promises to lead to important results in extending the use of this motive power in grinding grain, handling and storing produce, and doing some other kinds of farm work practically without expense, which formerly required a considerable expenditure for man or animal power.

NEED OF AN EXPERT IN FARM BUILDINGS AND MACHINERY.

The requests of the colleges and stations for aid in carrying out these investigations and in planning courses of instruction have been supplemented by numerous similar requests from farmers for advice and assistance about the selection and operation of different kinds of farm motors and other farm machinery. In the absence of any special arrangement for dealing with these problems, they have been referred to the Office of Experiment Stations and dealt with by the Irrigation and Drainage division of that Office; but there are at present no funds which can be utilized for systematic work along these lines. I am of the opinion that results of great value, alike to the farmers and the manufacturers of agricultural machinery, will come from the extension of the Department's work in agricultural engineering to include studies of this character, in cooperation with the agricultural colleges and experiment stations. I have, therefore, asked Congress for an appropriation which will enable us to employ an expert in farm buildings and farm machinery, in connection with the irrigation and drainage investigations.

DIVISION OF PUBLICATIONS.

The publication work of the Department is a faithful reflex of its activity and growth. The diffusion of the valuable information acquired by the Department is effected almost entirely through this medium. The time was, indeed, when in spite of the comparatively few publications issued, the cost of printing them amounted to far more than half the entire expenses of the Department. At present the entire cost of this work is not even one-sixth of the total expenditures of the Department, and yet the number of publications issued during the past fiscal year aggregated 972. Of these, 379 were new, comprising about 23,000 pages of matter. The number of copies of all publications issued during the year aggregated 12,421,386. The 600 reprints attest forcibly the extent of the demand for the Department publications.

Of the whole number printed 415 were Farmers' Bulletins, of which 25 were new and 390 reprints. The total number of copies of these issued during the year was about 6½ million, very nearly 5 million being distributed upon the orders of Senators, Representatives, and Delegates in Congress.

A very gratifying feature reported by the Department Editor is the constantly increasing demand for the Department publications by educational institutions, mainly for class work. This has added, however, very much to the demands made upon us, and, unfortunately, has greatly increased the instances where it has been found impossible to comply with applicants' requests owing to the exhaustion of the supply.

This suggests the possibility, with the cooperation of Congress, of utilizing, after sufficient time has elapsed, a portion of the unused Congressional quotas of many of our documents. If some plan could be devised, with the approval of Congress, whereby such unused quotas could be made available to the Department, a great deal of valuable matter would go into circulation which at present is not used in any way.

PROGRESS ON NEW DEPARTMENT BUILDINGS.

The work connected with the new buildings for the Department of Agriculture, authority for which was announced in my last report, has progressed satisfactorily during the year. As already announced, Congress has authorized an expenditure of $1,500,000 for these buildings. For the greater part of the past year the architects have been engaged, under the direction of a committee consisting of three bureau chiefs in the Department, in preparing the detailed plans and specifications for the buildings. The plans were completed in full August 25, 1904, and steps were at once taken for the securing of proposals. In asking for proposals it was planned to have the matter considered under two general propositions: (1) The buildings to be erected entirely of granite, and (2) the buildings to be erected with granite base and marble superstructure. Twenty bids for the entire work were received, opened, and scheduled on November 10. The bids on the complete structure ranged from $1,153,000 to $1,612,000. After careful consideration by the building committee and the architects, it has been decided to erect the buildings with granite base and marble superstructure. The two lowest bids for this work were submitted by Mr. Ambrose B. Stannard, of New York—one for $1,206,000, the other for $1,199,000, the difference of $7,000 in price being caused by the difference in style of granite used for the base. The committee has unanimously recommended that Mr. Stannard's bid for $1,206,000 be accepted, and this has been done. It is gratifying to announce, therefore, that the actual work on construction will begin within the next few days.

THE LATE COL. J. H. BRIGHAM.

In concluding my report, it becomes my sad duty to record the death of Col. Joseph Henry Brigham, Assistant Secretary of Agriculture, which occurred suddenly at Delta, Ohio, on June 29, 1904.

Colonel Brigham enlisted in 1861 and served throughout the war with great credit, being mustered out with the rank of colonel. From the date of his enlistment, Colonel Brigham may be said to have devoted his life to the service of the public, and especially to the cause of agriculture. He was for six years a member of the Ohio State board of agriculture, and served one year as its president. He had also served in the Ohio State senate, and had been appointed by the late President McKinley, then governor of Ohio, president of the State board of managers of the penitentiary of that State. Prior to his appointment by President McKinley to be Assistant Secretary of Agriculture, however, he was perhaps best known as master of the National Grange, a position which he held for nine years.

While he was serving as Assistant Secretary I had the honor to recommend him for appointment on the Government board of managers of the Pan-American Exposition as the representative of the Department of Agriculture, and he was subsequently appointed chairman of the board by President McKinley. By your appointment he held the same position on the Government board of managers of the Louisiana Purchase and the Lewis and Clark expositions, and he was filling these positions when he died.

Colonel Brigham was frequently designated to represent the Department at important gatherings throughout the country, and on all such

occasions he not only succeeded in interesting and impressing his audience, but by his unassuming deportment, genial yet dignified, he added greatly to his own and the Department's popularity. At his funeral at Delta, Ohio, on the 3d day of July last, which served to demonstrate in a marked manner the high esteem in which he was held by his fellow-citizens, his friends and neighbors, the Department was represented by a committee of its officers appointed by me for this purpose.

Born and bred a farmer, Colonel Brigham was a notable example of a man who attained eminence without ever abandoning the occupation of his youth. His experience and judgment, his public spirit and fidelity to duty, made him valuable in every position which he filled, and it is with a deep sense of personal and public loss that I pen this record of his death.

In the foregoing report I have endeavored to show the relation of the farmers to their coworkers throughout the country, and also the leading position which agriculture occupies among our industries. I have endeavored to give an outline of some of the directions in which the Department seeks to help the farmers of the United States. Its existence is justified only by the extent to which it serves the tiller of the soil through research and the practical application of science.

Respectfully submitted.

JAMES WILSON,
Secretary.

WASHINGTON, D. C., *November 26, 1904.*

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U. S. DEPARTMENT OF AGRICULTURE.

Report No. 80.

PROGRESS

OF THE

BEET-SUGAR INDUSTRY

IN

THE UNITED STATES

IN

1904.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

[Concurrent Resolution of March 2, 1905.]

Resolved by the Senate (the House of Representatives concurring), That there be printed twelve thousand copies of the Report on the Progress of the Beet-Sugar Industry in the United States in nineteen hundred and four; one thousand copies for the use of the Senate, three thousand copies for the use of the House of Representatives, and eight thousand copies for the use of the Department of Agriculture.

MESSAGE

FROM THE

PRESIDENT OF THE UNITED STATES,

TRANSMITTING

A REPORT ON THE PROGRESS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES IN 1904.

FEBRUARY 15, 1905.—Read; referred to the Committee on Agriculture and Forestry, and ordered to be printed.

To the Senate and House of Representatives:

I transmit herewith for the information of the Congress a report on the Progress of the Beet-Sugar Industry in the United States in 1904. Your attention is respectfully invited to the accompanying letter of the Secretary of Agriculture, recommending that 10,000 copies of the report be printed for the use of the Department of Agriculture in addition to such number as may be desired for the use of the Senate and House of Representatives.

THEODORE ROOSEVELT.

THE WHITE HOUSE, *February 15, 1905.*

LETTER OF TRANSMITTAL.

DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., February 11, 1905.

MR. PRESIDENT: I have the honor to transmit herewith for your information and that of the Congress of the United States a report entitled "Progress of the Beet-Sugar Industry in the United States during the year 1904," prepared by Mr. Charles F. Saylor, special agent of this Department.

In view of the popular interest in the industry mentioned, I respectfully recommend that at least 10,000 copies of the report be printed for the use of this Department in addition to the number which Congress may in its wisdom order for the use of the members thereof.

I have the honor to remain, Mr. President,

Very respectfully,

JAMES WILSON, *Secretary.*

The PRESIDENT,
The White House.

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PROGRESS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES IN 1904.

REPORT OF SPECIAL AGENT,

CHARLES F. SAYLOR.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SPECIAL AGENT,
Washington, D. C., February 9, 1905.

SIR: I submit herewith for your inspection and approval the manuscript of my report on the Progress of the Beet-Sugar Industry in the United States in 1904. It includes a general review of the successes and failures of the year and a discussion of the influences and conditions that are operating favorably and unfavorably on the development of the industry. The present conditions in all the beet-producing States and the prospects for new factories are reviewed at some length.

Respectfully,

CHAS. F. SAYLOR, *Special Agent.*

Hon. JAMES WILSON,
Secretary of Agriculture.

INTRODUCTION.

This report on the Progress of the Beet-Sugar Industry for 1904 is the eighth annual report prepared and submitted by the author on the subject.

Like all new enterprises, the sugar industry as it stands to-day is necessarily the product of the conditions involved in its environment and history. Many of these conditions were unforeseen and unanticipated. It seemed reasonable eight years ago that a nation so progressive as ours, so essentially agricultural in its resources, so cosmopolitan in its markets and demands, should exert itself to the limit of its abilities in supplying its own needs. Eight years ago the beet-sugar industry was so slightly developed and so restricted in territory as to give only a hint of its possibilities. Our past achievements in well-established lines of agriculture, our broad expanse of agricultural

land with a great variety of soils and climatic conditions, and our great and rapid industrial development strongly suggested the possibility of establishing a great beet-sugar industry. We were practically supplying home demands and selling to other countries a large supply of dressed meats, live stock, poultry, eggs, cotton, grain, flour, and other products of the farm; and our agricultural exports were constantly increasing. The farm was a most important factor in the balance of trade in our favor with other nations of the earth. It seemed illogical that we should be buying abroad at that time $100,000,000 worth of a product that was so purely agricultural in its nature as sugar.

The beet-sugar industry appealed to intelligent agriculturists as one which would promote rotation of crops, increase the fertility of our soils, and give us a better balanced production of live stock, grain, forage, and root crops. To thoughtful business men the importation of such a large item of one of the necessaries of life indicated a failure to realize and utilize our natural advantages. These facts attracted popular attention and aroused the interest and ambition of our people to attempt the establishment of the sugar-producing industry. The press, the people, and the State and National governments joined in an agitation that soon reached the proportions of a crusade in behalf of this industry.

In the work of development which has been done during the last eight years it would be surprising if some mistakes were not made. The agitation was based on logical principles, the general anticipations were rightly founded, and in the main the results justify the efforts which have been put forth. Ambitions and hopes can be realized only through efforts made in harmony with actual conditions. It was impossible to mark out the path of development or foresee the obstacles to be encountered and the difficulties to be overcome in launching such an industry. In looking back we realize that no one appreciated the real difficulties surrounding the beet-sugar industry. No one can study them and become sensible of the importance this industry has assumed and not decide that the demand for home production to the extent of home consumption was and is logical. As to exportation of this product it is a question that can be safely left to the future development of our resources, conditions, and markets.

The past season can be fairly rated throughout the different portions of the United States as favorable to the production of sugar. The success attending the beet crop is offering much encouragement and considerably improving the prospects of sugar production next year. The shortages of beets grown last season were not due to a failure of the yield either in respect to quantity or quality, but to the limited acreage secured by factories in many localities. Many things tended to favor the sugar industry the past year. The season was

quite favorable throughout the country. There has been a tendency toward steady and good prices for sugar; the beets have shown an unusually high sugar content; European production has been considerably diminished, and the indications are that it will continue to contract. There has been a steadier home demand and a larger consumption of sugar this year than during any other except one in our history. Decrease of foreign production and steady increase of home consumption are two factors that appear likely to operate steadily for some time to come, and these are the factors that largely govern the price of our home product.

There were four factories installed and put in operation during the past season. As is usual with factories recently built, they are of large capacity. Three of them slice 600 tons of beets each per day, and one of them 1,200, making a total of 3,000 tons per day of additional capacity installed during the past year. It is interesting to note that two of these factories were installed in Wisconsin, where beets are grown without irrigation, and two of them in Idaho, where irrigation is practiced.

There are some features of the development of the beet-sugar industry that deserve mention in this introductory summary.

There has been more progress made in the sale and use of by-products during the past season than in any previous year. Often in former reports I have pointed out the influence which the sugar industry exerts on the stock-feeding interests. It is to be noted that farmers everywhere are becoming more appreciative of the feeding value of the two by-products, pulp and molasses. Stock interests are rapidly increasing in factory districts, owing to the feeding of pulp, and the farmers are more generally using it.

We now have twelve States interested in the production of beet sugar, in four of which irrigation is practiced and in eight of which rainfall alone supplies the moisture for the growth of crops. However, it must be noted that, as a rule, the irrigation States are the ones which are establishing not only the larger number of factories but the largest in size. Throughout these twelve States, scattered as they are from the Atlantic to the Pacific, are brought into use many different soils, conditions, and resources. We are growing sugar beets through artesian systems of irrigation and by irrigation from running streams and storage systems, partly by irrigation and partly by rainfall, and wholly by irrigation. We are growing sugar beets without irrigation in States where the moisture is hardly sufficient and in States where it is more than abundant. We are growing them in heavy clay loam, in sandy loam, in clay soils, and in silt soils. We are growing them in the river valleys, on the uplands, and on steppes of the mountains.

Through all this experience under different climatic conditions, with

varied soils and resources of every description, we are receiving information that is most useful in the future development of this industry. The industry is, in fact, constantly acquiring more settled and definite status. Any new factory installed now is founded upon conditions which have been investigated and are known to be satisfactory.

There is apparently a better understanding of and a well-grounded confidence in the conditions affecting this industry. Capital appears better able to grasp the possibilities of investment, to look beyond the pioneer experiences incident to every new sugar factory, to better comprehend the general advantages which can only be fully enjoyed when all conditions are thoroughly developed. The few failures which have occurred, through mistakes in locating or constructing or capitalizing concerns, while they are serious matters affecting the investors involved, are proving valuable guides to those interested in future extension of the industry.

The number of factories in the United States in 1904 was as follows:

Number operating	48
Completed plants not operating	6
Building and partially completed	3
Slicing stations	4

Those operating are distributed as follows:

California	5	Ohio	1
Colorado	9	Oregon	1
Idaho	3	Utah	4
Michigan	16	Washington	1
Minnesota	1	Wisconsin	3
Nebraska	3		
New York	1	Total	48

Of those not operating, California has 3, located at Chino, Crockett, and Watsonville; Michigan has 3, located at Rochester, Bay City, and Carrollton. Of the slicing stations, Utah has 3 connected with the Lehi plant; Idaho has 1 connected with the plant at Sugar City.

Of the 3 factories building during the year and but partially completed, Michigan has 2, located at Charlevoix and Mount Pleasant, and Arizona has 1, located at Glendale, near Phoenix.

At first glance the idle factories might appear a little discouraging, but it is safe to say that the percentage of idle plants in the United States is not nearly as heavy as the yearly average for the past ten years in Germany, France, and other beet-sugar countries. The idleness of some of these plants has resulted from temporary causes. About half of them are idle from causes which at present seem permanent; but these may become active producers under more favorable conditions. In some cases negotiations are under way having in view the moving of idle plants to locations more suitable for the industry.

In fact, one of the plants erected this year, which has every prospect for a successful future, was removed from a location where obstacles seemed insurmountable. Another factory in the West, which had a disastrous career and finally closed down for a couple of years, reopened with a good supply of beets during the last campaign, was quite successful, and bids fair to continue active in sugar production. The reaction on local sentiment which resulted from its closing brought about the favorable conditions necessary to its success. In this case it was purely a matter of securing a sufficient supply of beets.

This was the main question involved in the closing of other factories which are now idle. Where sufficient beets can be secured, nearly every other difficulty can be overcome. To a locality where the farmers are willing to grow a supply of beets capital and labor are at once attracted. In the case of this Western factory, which remained idle for two years, its advantages became apparent to the community through their loss. Every interest connected with the factory during its period of rest had an opportunity to study the causes contributing to its failure. The factory was reorganized, and those interested united their forces and planned to avoid the difficulties. As a result, the work of the factory and the farmers was much more satisfactory and remunerative. It is safe to predict that half of the idle plants will gradually, in some way, work back into active operation.

The difficulty with most of the factories which have not succeeded was too great haste in their establishment and building factories in too close proximity before conditions had sufficiently developed for them to secure a supply of beets. The success attending beet growing this year has brought about a marked change in the facility with which the factories operating in the same districts are now securing additional acreage for next year's campaign. Most of them will have procured sufficient acreage by January 1, 1905, to meet the requirements of a full campaign. Around these active factories, as compared with other years, there is a marked change in the willingness of the farmers to grow beets. It appears certain that another campaign will see some of these idle plants in operation, and by 1906 possibly all of them.

MISTAKES MADE AND OBSTACLES MET AND OVERCOME.

All persons and organizations interested in the development of the beet-sugar industry, including the Department of Agriculture, have reason to congratulate themselves on the results attained up to the present time. The future prospects of the industry seem most auspicious.

A brief account of the mistakes which have been made and the obstacles which have been met and overcome ought to be of interest at this time.

THE SUPPLY AND CHARACTER OF LABOR FOR THE BEET FIELDS.

While eight years is not a very long period in the experience of men or the affairs of a nation, it is sufficient to give us a large fund of information regarding the manufacture of beet sugar. Eight years ago a boy 9 years old on a farm may have had his first experience in weeding and thinning beets. To-day such a boy is 17 years old and thoroughly equipped with all the information necessary to the practice of growing sugar beets. To-day there are thousands of boys who have developed in this way. What has been said of the boy is equally true of his elders. The one great thing lacking at first was information on the subject. This is true of those connected with factories, as well as those working on the farm. Lack of information regarding the best methods of farm and factory management has been the cause of most of the difficulties affecting the industry.

Fortunately for the beet-sugar industry its first development was inaugurated in those countries of Europe in which the people were accustomed to hard, laborious work and even drudgery. In those countries with congested populations and high-priced lands agriculture is necessarily intensive. Through a long line of succession from father to son the people were accustomed to the closest economy, and did not shrink from the labor involved in producing the most from the least land. In several such countries sugar beets became a main crop, and the work of their production became intimately interwoven in the daily life and duties of these peoples. The farmers learned to grow sugar beets successfully and they taught the art to their children. An unfavorable season or any mishap to the crop had no tendency to discourage beet production. It was clear to them that the same things happened to other crops. Such conditions were very different from those which prevailed in this country when the establishment of the beet-sugar industry was undertaken.

In this country we are devoted to the production and use of labor-saving machinery. Our tendency has been away from rather than toward hand labor. In those old countries the farmer and every member of his family were workers in the beet fields. Here the farmer and the hired men do the work; the children attend public schools and colleges. Our farmers and hired hands not only do the work on the farm, but as a rule they do it with labor-saving implements, the main point being to eliminate every form of drudgery. Now if there is any one thing required in the beet field it is hard work and plenty of it. Sugar beets are an expensive crop. Given sufficient attention and labor they are highly remunerative under ordinary conditions. If neglected they are just as sure to carry the farmer's bank account the other way. It is plain that to grow sugar beets to any extent a farmer will necessarily have to employ considerable labor during the growing

season—much more labor than is customary with other field crops. Starting with the labor conditions prevailing in this country, it must be evident that our farmers were, as a rule, unprepared for the task of growing sugar beets extensively. In many places large fields were planted to beets with insufficient labor to do the work.

A good yield of beets will pay the expense of production and leave the farmer a fair profit. Often expenses were estimated too much by comparison with the cost of producing other crops. Disaster naturally followed in such cases, and the farmer decided not to raise another crop. It is evident that if sugar beets are to be produced in this country it must be done by a system of labor which is in harmony with American ideas, conditions, and aspirations. We could not adopt to any extent the family labor system prevalent in Europe. Our young people must not be deprived of educational advantages.

However, I have pointed out in this, as in several former reports, the practicability of using the children of cities in the beet fields to a considerable extent, without violating any of our ideals. I have also pointed out that there are many sources of supply of labor to supplement the farmer's own work, and that we can rely on the beet crop itself to meet the extra expense involved. But none of these things were appreciated by our pioneer beet farmers.

COMPETITION WITH FAVORED CROPS.

I have spoken of the tendency to grow particular crops in particular areas. In Germany, France, Russia, Switzerland, Italy, and some other European countries this tendency appears strong. Grain growing, potato growing, fruit growing, grape culture, and the other lines of production become localized. The same is true of the United States, but to a less extent and less definitely. As our country grows older and demands and resources become better defined there is a marked tendency toward intensive agriculture directed to the production of particular crops. Producers of a particular crop become wedded to it and are more or less on the offensive and defensive with reference to it. This has made it necessary for the friends of the beet-sugar industry to expend considerable energy in order to induce farmers to take up the new line of production. In rural life the themes of conversation and public interest are limited largely to local affairs, and there is a tendency toward conservatism. Every new undertaking must pass muster in all the public and private meetings of the people. The particular lines of production to which the people in a given community are devoted are more or less remunerative and satisfactory. This must be true or they would not receive such exclusive recognition. In many instances a sugar factory has been located in a community particularly devoted to some special crops. The

factory is of a certain capacity, measured in the number of tons of beets required to keep it employed.

It does not propose to begin on a small supply of beets and gradually work up to its full capacity, but wants a full supply the first year. The established lines of production in the locality had a small beginning, and worked up gradually; and they are sure to have their special friends and defenders, who do not propose to change from their specialty till they see the success of the new crop demonstrated. More than likely they will insist on some other person making the demonstration, and after it has been made will still be inclined to question the result. It is enough to say that the jealousies and opposition of these specialty crop producers have been serious obstacles in the way of success in the starting of new beet-sugar factories.

Though supported by the best energies of its owners and the special bounty paid to the beet growers by the State, during the past season the factory at Binghamton, N. Y., gave up the contest and was removed to Blackfoot, Idaho. It could not secure sufficient beets to warrant its continuance in New York. Without the beets it had no mission. It was the victim of too much peppermint, cabbage, broom corn, and other specialties. The farmers who supplied this factory with beets, who stuck to it until they were adepts, remained loyal to its interests although they had had experience in producing the other crops named. The trouble was largely due to the fact that beet growers would not survive the first year's experience—would not continue long enough to really test the merits of sugar beets as a crop. They would go back to the old crops.

The factory at Grand Junction, Colo., with favorable conditions for beet growing in its vicinity, but in a community devoted to fruit growing, had to suspend for a period of two years on account of lack of local sympathy. It took these two years to overcome the local prejudice. But it has done so completely, as the results of last year's work will indicate. I could point out many other instances where this lack of local sympathy, due to interest in other special crops, has been more or less serious.

NEW METHODS ON THE FARM.

Granting that the farmer sought and secured enough laborers, he was still confronted with the necessity of employing new methods in beet culture. He had to learn methods suited to his particular farm and locality, as well as the general principles of soil fertility and culture applicable everywhere. Some farms are in a state of tilth and fertility suited to beet production, some require applications of barnyard manure, and others positively need commercial fertilizers. Some require summer-fallowing and others subsoiling. Many things are

required to which the new beet farmer is unaccustomed, although he may be recognized as a successful farmer.

The farmer is naturally conservative. When he adopts sugar-beet growing, his success in other lines is as likely to count against him as in his favor. His experience has convinced him that there is a general similarity in methods of raising other crops. This is liable to make him think he is capable of following his own methods in growing sugar beets, especially since he has never been accustomed to following the directions of anyone.

In growing sugar beets a farmer finds laid before him specific directions for the preparation of the soil, the planting, thinning, and harvesting of the crop, and over him an agricultural expert, representing the factory, who assumes to advise and direct him. Such proceedings are naturally at first galling and exasperating to an independent American. Farmer A says, "What's the use of planting 15 or 20 pounds of seeds to the acre and afterwards thinning out 90 per cent of the plants? The factory simply wants to sell me seed." He cuts down the amount to what he deems necessary and secures a poor stand, probably no more than three-fourths or one-half of a full stand. Again he says, "What is the use of all the deep plowing? I will plow my beet land as I would for planting potatoes. They are both root crops, and why not?" He does so; plants his crop and gets an ill-shaped, sprangly, forked beet, low in sugar and purity. "What is the use of all this harrowing and pulverizing of the soil? It is not necessary for potatoes or corn or any other field crop that I know of. It adds to the expense and is useless." He plants his seed in rough, cloddy ground. Through this error many of the seeds lie in air chambers, where they fail to germinate, and many others which germinate, dry out and die. This again seriously affects the stand of beets. The first cultivations are laborious, the weeds and grass get a start, and Farmer A is not able to overcome them on account of the mechanical condition of the soil. He has a poor stand, a weedy field, a poor crop, and he is chagrined. Finally he lays the whole trouble to the difficulty of growing sugar beets, and declares that he will grow no more.

Many times in many parts of the country, such a man has said to me: "I am considered one of the best farmers in these parts. Now look at that field. If I can't grow beets, what are a lot of these other people going to accomplish?" Now, here is an honest, progressive, energetic, thrifty farmer, who wants to do things right. He is unable to set aside the information he has acquired regarding the growing of other crops during a lifetime, and to approach a new branch of farming with an open mind. His mistake will become evident to him some day. Many of the farmers around the sugar factory in his locality succeed. They renew their contracts. Additional ones appear on the list each

succeeding year. By degrees his folly becomes apparent to him and he makes a second trial, with much better results, and continues growing sugar beets. Some day his practical experience will enable him to set experts and written directions at naught.

I do not mean to say that the majority of our best farmers follow the course outlined above, but, taking the country over, there are many who do, and such have contributed not a little to the idleness of some factories. Their influence is as bad as their practice. Their model farming in the neighborhood has caused others to prize their advice and emulate their example. Their influence means much in determining the success or failure of the sugar factory. In the absence of knowledge of his own on the subject of growing beets, had such a farmer applied that of others in the same degree he applied his own to other crops, he naturally would have been successful from the beginning. When he learns to do this he will become a resource of strength to the beet production in his community.

On first thought it would hardly seem fair to charge a farmer with extravagance. Directly, farmers are probably freer from extravagance than most other classes of our people. He is naturally frugal, self-denying, and economical. But after all, economy is a relative term, and often in its application to practical affairs it leads to extravagance. And it is in this sense that farmers may be charged with extravagance in beet growing.

When agitation begins and public sentiment is aroused to the point of securing acreage for a sugar factory, the farmer naturally falls in line with the trend of public sentiment and becomes desirous of helping the cause along. He contracts to grow a certain number of acres of beets. For him to refuse to purchase a sufficient amount of seed is purely a matter of extravagance. It is a waste of land, time, and labor.

In selecting the land he reasons as follows: "I have agreed to grow 5 or 10 acres of sugar beets. Now, I don't know about this crop. The north 40 is good corn ground; I want to put that south 80 in oats and the 10 acres across the creek in potatoes. There is that 7 acres across the slough where the weeds got the best of me last year. It is sandy and more worn-out than the rest; I know what I can do with my good land in these other crops; I am not sure about this beet business anyway. I will try that 7 acres in beets." Now, if one requirement in raising beets is more important than another, it is land of a good quality and in fit condition. Good beet land is the very best land obtainable on the farm. There never was a greater error generally promulgated and popularized than that beets should have sandy soil, especially a worn-out soil, and sandy soils are the lightest and first to become worn-out. There is no crop adapted to a wider range of soils than sugar beets. They do well in sandy loam if fertile.

in clay loam and in most clay soils, in black loam, and in the various shadings of all these soils. In sections where rainfall is the source of moisture supply, it will cost at least $30 an acre to grow sugar beets. Where they are irrigated, it will cost at least $40 an acre. This represents too much money to be frittered away on soils naturally giving poor yields. It can be considered nothing but pure extravagance in business methods to attempt the experiment. It will require at least 6½ tons of beets in the rainfall areas and about 8 tons in the irrigated areas to pay the cost of production to the farmer. He can not reasonably expect more than this on poor land. If he is to grow sugar beets, it should be on land capable of producing a profitable crop; it should be on ground which has been so handled previously as to educe to a minimum the cost of cultivating sugar beets.

The economical method of growing sugar beets is to do everything required and do it exactly on schedule time. As a rule it is desirable to harrow sugar beets or use the weeder before they come up, and to do the same thing soon after they come up, repeating the operation two or three times when necessary to overcome the weeds. The beets should be cultivated as soon as the farmer can see the row, and thinned at the right time. This matter of thinning is the cause of more annoyance and expense than almost any other feature in the process of cultivation. There is a time when this can be done with the least expense and the least disturbance to the plants left standing. Every day's delay after the proper time of thinning has come adds greatly to the expense of the work and the disturbance of the beets that are to form a crop. If neglected too long, the farmer will probably lose several tons of beets per acre.

To explain how this is often done I will again let the farmer tell his own story: "I have not been able to get into those beets. I want to catch up with my work, cultivating my corn ground first. We have had considerable rain and I am behind. I don't think it will pay me to go out and hire a lot of people to work when I can just as well do it myself a little later on." Now, everything depends on getting sufficient people into the beet field to do this particular work at this particular time. If done on time and in the right way, the expense is all covered by the additional yield, by better beets, and by lessening the work which comes later; and the farmer is more than compensated when he sells his crop.

In the beginning of the industry the cultivation of sugar beets, like many other features of the work, proceeded in a haphazard, shiftless, unmethodical manner. Shallow plowing, slack harrowing, poor seeding, neglect of thinning, and poor beets were the rule. It seems that nothing but experience could eliminate this kind of farming from the sugar-beet fields.

Of course there were a few farmers who from the first gave careful

study to every detail, appreciated the necessities, followed the directions, and reaped their reward. Every successful season saw large additions to this class. Pay day was the final test of the methods that paid best, and proper methods became contagious.

Eight years' observation of beet growing throughout the country leads me to offer this advice: If a farmer makes up his mind to grow sugar beets, they should be planted on the best land he possesses; he should invest sufficient money in labor to do all the work required, and at the proper time; and he should do it cheerfully and promptly, or stay out of the beet-growing business.

BAD SEASONS, DISEASES, AND INSECTS.

Unfavorable seasons appearing at critical times have added much to the discouragement of farmers. During the early stages of many of our factories there was a general prevalence of drought, producing poor crops, and lasting for two or three years. This period was followed for two years by excessive precipitation in the States lying in the rain belt. The effect of these bad seasons was the discouragement of beet growers, especially the farmers who were making their first attempts. The excesses of drought and rainfall, however, affected seriously all other crops, and usually in a more marked degree than sugar beets.

With other crops the farmer was accustomed to losses by occasional occurrences of this kind. He had not had the opportunity of producing a good crop of sugar beets under normal conditions. He seemed to lay his misfortunes to the crop itself. It takes time to eradicate the disposition to do this. Farmers have now had the opportunity either to observe or experience both the good and the bad results of beet growing.

Four years ago there was a general prevalence of diseases and insects, which produced great havoc in many districts. The growers were entirely unacquainted with this phase of sugar-beet culture. Considerable public interest was aroused. Much was said and written on the subject at the time. Scientists investigated conditions and studied like occurrences in Europe. Congress appropriated money for investigation and the discovery of remedies for diseases and pests in our beet fields. Many were fully convinced that these had been imported with the seed, that we had introduced evils that would plague us constantly, and that they might actually defeat the efforts to establish the industry in this country. The following year was anxiously awaited for developments in this respect. They have never been repeated to any appreciable extent. We have learned that beets, like any other crop, are subject more or less to evils of their own, but not to any greater extent than other crops. Nothing has attacked sugar beets with results at all comparable with the ravages

of the chinch bug, the Hessian fly, the cotton boll weevil, or the grasshopper, to which other crops are subject; but it takes time to enlighten the people on a subject of this kind, and there can be no question that the unexpected attacks of insects and diseases in 1900 contributed very largely to the discouragement of farmers.

WASTE OF BY-PRODUCTS.

The first sugar factories went into districts not especially developed in stock production, especially in the intensive features of animal husbandry. Dairying, stock breeding, stock feeding, and creamery production were largely confined to the older States of the East and Middle West which were better developed agriculturally. Had the beet industry developed chiefly in these older and more highly developed communities, the factories would undoubtedly have found an immediate demand for their entire output of by-products. This is illustrated by the experience of the two factories operating in New York, and the one at Fremont, Ohio; also by the readiness with which pulp feeding was taken up in Minnesota and Wisconsin, two dairy States.

The bulk of the pulp produced at the beginning of the sugar industry was in States in which stock interests were either not highly developed or consisted largely in grazing. The result has been that the farmers have been very slow to take advantage of one of the greatest opportunities offered by a sugar factory. The State of Michigan, for instance, in which at one time twenty factories were in operation, was not especially developed in stock interests. Within a short period twenty large concerns were established which put out thousands of tons of beet pulp and hundreds of barrels of waste molasses, both most excellent stock foods. Yet these, as a rule, were thrown away in the ravines, bayous, and waste places. There has, however, been great improvement in Michigan in this respect. The farmers are more generally feeding the fresh pulp. Two factories have installed pulp drying plants and are building up a demand for their finished stock-food product at paying prices.

If the farmers of Michigan, or any other place for that matter, where sugar factories are in operation, had grasped the full import of the advantages offered by a sugar factory, there would not now be any sugar mills whose idleness requires explanation. A sugar factory is not simply a market for a certain crop. It increases the values and rents of the farmer's lands. He can raise a crop of beets in which, from air and water, the sun has elaborated a certain amount of sugar, requiring nothing from his soil so far as the sugar is concerned. He hauls these beets to the factory, which buys the sugar and extracts it. The farmer receives his money for the sugar, and brings back home the residue of the beets—the pulp—and feeds it to his stock.

This pulp has been purchased from the factories for almost any price, from nothing to $1 per ton, depending upon the location of the factories. In many cases it was given to the farmers, and in many others they paid from 10 cents to 35 cents per ton—merely a nominal price—for a valuable feed. If the farmer had known in the beginning what most of them now know, he would have immediately increased the stock of his farm when he began growing sugar beets. He would have taken all his pulp, fed it to his stock, produced milk and meat, and sold them. He would have taken the resulting barnyard manure and put it back upon his land. If the farmer had adopted this policy and kept it up, there would have been no idle sugar mills now. He would now be able to say: "This beet business is all right. I grow a crop, sell a portion of its constituent elements to the sugar factory, bring back the rest, and feed it my stock, so that I do not have to devote other land to the growing of feed; I sell the animal product from this feed; I am able to keep more animals, and maintain a better balance between stock and crop production, and I am better able to keep the fertility of my soil up to the standard. The cultivation of sugar beets puts my land in much better condition, and I am able to largely increase the production of other crops."

There is no question that farmers living in the vicinity of sugar factories are now thinking more seriously along these lines, and that their more active support will greatly benefit the sugar factories in the future.

USE OF POOR SEED.

There can be no question that a good quality of beet seed is a paramount necessity in growing the crop. The selection of land has been mentioned as of first importance, if there is one thing more important than another. In this the responsibility lies with the farmer himself. Of course the agricultural experts of the factories give this matter considerable attention, but they must be guided more or less by the farmer's own statement as to the quality of his land. After the expert has made his recommendation the farmer still has the responsibility of following the directions in making the selection.

Selection of seeds is also of paramount importance. In the choice of seed the farmer must be relieved from any responsibility in the matter. The two important characteristics of good seed are (1) vitality or germinating power, and (2) the power to produce beets of high sugar content and purity. In regard to choice of seed the farmer must be guided entirely by the experts of the factory. So important is the use of good seed that the contracts of every sugar factory with which I am conversant require the farmers to use the seed furnished by it. The vitality of the seed materially affects the stand of beets. Many contracts provide that the price to be paid for the beets shall

depend on the amount of sugar they contain. On this account the farmer is deeply interested in the reproductive power of the seed.

On the other hand, the factory is interested in the farmer securing a good yield of good beets in order that it may retain him on its list of beet growers. It is also interested in the sugar content and purity of his beets, since it can work high-grade beets at less expense, ton for ton, than beets of low purity and sugar content. Since the great bulk of the beets grown for the factories in this country are from seed imported from Europe, the factories are dependent for the quality of their seed upon the foreign beet-seed producers. From this fact have resulted many of the difficulties that have beset beet-sugar production in many parts of this country. Too much dependence was put upon the representation of the seed producers of foreign countries.

We began the production of beets in this country with every indication that an extensive industry would be developed, affording a large market for beet seed, each factory requiring several carloads every spring. Without any special knowledge at home of quality, it was assumed that foreign producers of seed would vie with each other in building up this market, and that the natural laws of competition would bring us seed of first quality. In this the factories reckoned without their host, although results might have been different with the old reliable established seed firms of Europe. In this business, as in every other, there is a class of producers who cater to a "shoddy" trade. They were aware of our ignorance regarding quality in sugar-beet seed. Agents were sent over here who represented firms that were not scientific producers of beet seed, but who went out on the market of Europe and gathered seed from every source available, including old seed bins, and "sweepings" or "clean-ups" of thrashing floors. These were mixed more or less with fresh good seed and shipped over here as high-grade seed. In other cases the standard "A" seed, from which the best field crops of Europe are grown, was planted to produce mothers, from which a crop of seed was grown direct and shipped to this country. Beets were planted again from this second seed to produce mothers to be used in growing seed for our market, from which many of the beets for our factories were grown.

During the years 1903 and 1904 this country imported approximately 5,250,000 pounds of seed annually. This seed cost the beet growers, in round numbers, three-quarters of a million dollars each year.

From time to time our factory managers and experts, interested in the development of the beet-sugar industry in this country, have visited these older countries. They have found a sentiment there not conducive to our best interests in securing seed of the best quality. It must be evident that to build up the sugar industry in this country is more or less against the interests of these older countries. They

have been exporting to us a considerable part of the sugar we consume. It is of more importance to these seedsmen to have the beets grown there, so as to give them a home market for their seed, than to help build up an extensive sugar production here. They were perfectly willing to sell us the seed if we demanded it, but as to quality of seed they were not anxious to discriminate in our favor against their own home producers.

One of the best-known experts in the United States, who has devoted years to the beet production of Europe, said: "You can not dream of the disaster that would follow to the sugar production of the older countries if it were possible for them to export what is known as the high-grade 'A' seed. There is not nearly enough of the 'A' seed to meet the demands of European growers." It would appear to be a plain case, from this statement, that as a matter of fact there has been practically none of the "A" seed sent to this country. It is also a fact that we have not been able in all cases to secure the second-grade seed, such as is much in use there. Thus we have been hampered by crude ideas of our own in growing the beet crop, and to some extent by the machinations of irresponsible, designing seed dealers of Europe. There is absolutely no definite information as to the extent to which this has occurred. It is safe to say that this circumstance contributed much to the discouragement of our early beet growers. Finally it led to an investigation by home producers, as a result of which the evil has been largely corrected. Many of our managers, superintendents, and proprietors made personal visits to the seed-producing districts of Europe, studied the conditions of seed production there, and placed their contracts with responsible firms.

In my last report I made a detailed statement of the methods used in the production of high-grade sugar-beet seed. A perusal of this statement makes it clear that the process is expensive. It also shows that considerable time is required to carry out the successive steps involved in producing a crop of seed. These steps are necessary to maintain the high quality of the seed. Of this our factories are fully advised, and they have placed their contracts accordingly. I have known a case where the entire supply of beets for a factory for the season were the product of inferior seed, and the beets averaged hardly above 10 per cent of sugar, with the purity equally low. It was the factory's first campaign. No factory, no matter how large its supply of beets, could make a profit. It could not survive in competition with other factories securing beets with 15 to 17 per cent of sugar, and a purity of 80 to 90. In the case of this particular factory, the results of the first year's work were more disastrous. It could not survive the shock administered to its beet growers and financiers. It closed its doors and dismantled, and is no longer heard of. Such errors are not common to-day. They are hardly possible, but they

will remain green in the memory of those who are conversant with the things that crippled and hampered the beet-sugar industry in its earlier stages.

INADEQUATE EXPERIMENTATION.

The original information concerning the production of sugar beets in this country that was used as a basis on which to found the beet-sugar industry was secured by making experiments in raising beets in various parts of the country. Looking back, these experiments appear to have been inadequate, often ill-advised, and in a measure conducted in an irresponsible way. No doubt they were the best that could be devised under all the circumstances. They emanated from a great variety of sources. They were instituted everywhere and apparently by everybody—ministers, lawyers, doctors, farmers, editors, professional agriculturists, railroad companies, real-estate agents, college professors, State experiment stations, and the United States Department of Agriculture.

A great variety of printed matter appeared on the subject, ranging from statements based on the most meager information to the very learned translations of the most scientific character. In advice there was nothing lacking, such as it was, but there was no one particularly qualified to sift out the good from the bad. We were on the high road to the beet-sugar industry and nothing but experience could ever give us the real facts. That experience we now have had and it is not to be regretted. Out of all the confusion came some very valuable data. We have gradually learned right principles and discovered errors. Under the same circumstances I am sure that if we had the work to do over again it would proceed along the same lines. We simply started blindly and in the dark and felt our way out toward the light. Where definite knowledge and experience are lacking there is no better way.

Most of these preliminary experiments were conducted by farmers who secured seed from and worked more or less under the direction of some State experiment station, or the Department of Agriculture, or some association organized to promote the industry.

In 1897 the Department of Agriculture received thousands of individual applications for beet seed. Congressmen had small packages sent broadcast over their districts. Many of these packages contained accurate directions for conducting the experiments—some did not.

Ambitious towns, societies, and organizations of different kinds forwarded lists of farmers, to whom the seed was sent. State experiment stations made up from their bulletin lists a collection of names, asking them to make experiments.

The Division of Chemistry of the Department of Agriculture and the chemists of the State experiment stations requested these farm

experimenters to collect and forward samples of the beets grown for chemical analysis, and Government franks were supplied, to save the farmers expense in complying with this request. The samples came in by the thousand, in every form of order and disorder. Some beets were dried out and wilted before they reached their destination. A beet from which the moisture has evaporated before testing shows a considerably higher percentage of sugar. And there were many irregularities of this and other kinds.

The worst feature of these experiments appeared on the farms where the beets were grown. It seemed almost impossible to induce the farmer to set apart any portion of his good land for conducting these trials. He said: "I am getting nothing out of these beets, so what's the use?" As a rule farmers are not given to experimentation. A really scientific experiment ignores profit. It is purely an educational matter. Not a large number of our farmers incline to this sort of work. The same reasons that actuated them in the selection of the land operated in the cultivation of the crop. During the year mentioned I visited thousands of these experimental plats in different parts of the country and I think it is safe to say that I did not find over a dozen really well-conducted scientific experiments.

Upon such a showing of facts was our sugar industry instituted. In the light of such facts the reason for the obstacles encountered becomes clear. But to-day sugar factories are built in territory in which beets have been grown for the factories, thus demonstrating the actual fitness of the conditions.

INTERDEPENDENCE OF FACTORY AND FARM.

There is such a community of interests between factory and farm in the production of sugar beets and manufacture of sugar that it is hard to draw a definite line of separation. The factory is vitally interested in everything that pertains to the success or failure of the work on the farm. The factory must feel assured that the farmer is sufficiently remunerated to induce him to grow the crop. It is also directly interested in the quality of beets the farmer grows.

Every move on the farm or in the factory is intimately related to the cost of production. If the beets are brought in dirty, the manufacturer is at additional expense for cleaning them before they enter the processes of manufacture. Often in a load of beets there are pebbles, pieces of iron, and other articles which find their way through the sluice gates, into the elevators, and finally up to the delicate slicing knives. These are dulled or broken; machinery may be wrenched and disabled, causing loss of time and a large expenditure of money for repairs.

The very foundation of the factory's success in sugar production is its supply of beets. Every factory is constructed to slice so many

tons of beets per day (its capacity) and to continue the process for a certain number of days (its "campaign"). If it secures a sufficient supply of beets to meet this capacity for the full period, much has been accomplished to insure success.

Again, if the beets only contain a small percentage of salts of different kinds, naturally entering into the beets ("impurities"), the work is greatly facilitated. In the process of making sugar these salts operate to hold up the sugar from crystallization. Extraction becomes difficult in proportion to their presence. If the beets are high in sugar content, more sugar is secured from the same amount of beets and factory energy than would be the case if they were low.

The supply of beets, their purity and sugar contents, are all governed largely by the work on the farm, viz, the selection of the land, its preparation to receive the seed, the time and manner of planting, thinning, bunching, cultivating, and harvesting, and the delivery of the product.

TOO MUCH ENTHUSIASM AND HASTE IN ESTABLISHING FACTORIES.

The beet-sugar industry was started with a little too much of our well-known American enthusiasm. There was too much of the kind of excitement often aroused by the discovery of a valuable find in a new mine, or the selling of corner lots in a new town. Other leading agricultural industries had started with the early settlement and developed with the country; or, if introduced later, they came as natural results of specific demands. There were very few farm products the working of which required large capital. Probably the packing and milling industries of the country were most extensive of this class; but they began with our earlier history, were operated through pioneer methods, and gradually developed to large concerns. With the beet-sugar industry it was different. It was proposed to establish a factory at a cost of $500,000 to $1,000,000 in a community with absolutely no information concerning the needs of the industry. It was proposed to employ a small number of experts in the factory, but the proprietors themselves were absolutely without experience. But little was known concerning the agricultural problems involved in the growing of the beets. The first year nearly everybody was swamped with work in the fields owing to the lack of help, as insufficient arrangements had been made. The demand for more help came from every direction. Laborers were sought in the adjacent country, the cities, and more remote sources of supply. Only an insufficient supply could be secured, and the laborers were nearly all inexperienced.

Yet investors really anticipated a dividend the first year under such conditions. The farmer made a poor selection of soil, did poor work in the field, and delivered poor beets to the manufacturer. Also his

eyes gave heavier weights to his beets than the scales at the factories. When his beets were tared they were found to contain more dirt than he supposed. Contentions arose and bad feelings were engendered.

At least 60 per cent of the factories now in existence had to go through an experience of this sort. Capitalists, business men, and farmers all over the country seemed to have the one idea that a sugar factory was a highly beneficial institution financially. There is probably not a town or city in the sugar-beet belt that did not at one time or other have the beet-sugar craze. In their archives may be found the history of their agitation of the subject. A barbecue was held, the farmers of the surrounding country were invited in, the hat was passed to pay expenses. An ox was roasted and the public feasted in some hall or grove. The band played, the people shouted, and everybody shouted "Hurrah for the sugar factory!"

In many cases all this noise and enthusiasm led to the establishment of a factory. The town gave a site and exempted it and the improvements on it from taxation. The substantial basis for all this excitement was the fact that some experiments had been conducted on a few plats of ground in the neighborhood during one season, capitalists putting up the money, the farmers growing the beets. It is not my purpose to decry this enthusiasm, nor even to suggest that it was unwise. It was probably necessary. As a final verdict at least the results of most plants will substantiate the wisdom of their location. It is proper, however, to state that the early events in the operations of these factories should be viewed in the light of the facts just stated.

The sympathetic, intelligent, and active support of a farmer is as essential to a sugar factory as is food to an animal. In order that a farmer may produce beets for the factory, he must first be convinced that they are profitable, and considerably more so than other farm crops, as the expense of production is so much heavier. He must know how before he can produce beets at a profit or employ the best methods of cultivation.

The hurrah spirit has subsided. In its place we have the cold facts and conditions upon which rest the future of the sugar factory. Through the reaction most of the factories have passed successfully. A few are idle, with the issue indeterminate as yet.

The establishment of a new factory now proceeds on entirely different lines. With one or two exceptions the twelve States now producing sugar beets compose the area from which we will procure our beet sugar in the future. The factories now in existence are the training schools which promote the establishment of others. In securing its supply of beets a factory in the start naturally covers a large surrounding territory, but gradually contracts the area until it can secure a sufficient supply in its own locality. Perhaps a factory in another vicinity overlaps or reaches up to the area of the first, but its territory

also contracts in like manner. The result is that the farmers throughout a large district are educated in the art of producing sugar beets. They have also fully tested the fitness of the soil for the production of this crop. As the factories gradually increase their tonnage and secure their supply nearer home large areas where the farmers are educated in growing beets and desire to produce them are left without a market for the crop. A new factory becomes a necessity to this district. There is nothing haphazard about its introduction. Everybody interested knows exactly what can be accomplished. They go into the work with eyes open, each willing to do his share. The factory starts, and it succeeds from the beginning. It is thus that the extension of the beet-sugar industry now appears to be going on.

WORK OF PROMOTERS.

Mention of the promoter carries us back to the barbecue, the brass band, the public assemblage in the town hall. So many towns have had this experience that I will give one coming under my observation as typical of all.

A man had arrived in the town a few days before and had called on a few citizens of wealth and influence. He had a proposition to make. He said he was associated with several public-spirited financial gentlemen who were prepared to put up a sugar factory in that particular town. He had an array of facts showing the favorable conditions for beet growing in the farming community. The country could produce the beets, the town had the pure water, cheap transportation, good coal, limestone, and everything necessary near at hand. It was handy to market, and everything appeared to be in readiness for the building of a sugar factory. This would build up the town and start a boom.

All that he asked was that a few of the responsible people organize a beet-sugar company and subscribe for half the stock. He and his associates were to subscribe for the other half. In addition, he must have a bonus of $150,000, possibly to be taken in stock. The town was to give a site, connect it with the water main, put in a spur, exempt the site and factory from taxation for a period of years. The factory he proposed to build was a 350-ton plant, costing $350,000, which he proposed to stock for $500,000 in order to cover his bonus. It is probable that there was nothing back of Mr. Promoter. He intended to take the gifts and the prospects offered by the town to some beet-sugar factory constructor and propose that he take the contract to build the factory, taking as part payment some of the stock in his hands for disposal and find capitalists who would pay cash for the rest.

I do not know that many factories were constructed as a result of such promotion. The promoter early demonstrated himself a failure as a factor in developing the industry. He was a positive hindrance

to it. He wrought up many localities to a high degree of anticipation. After long waiting the bubble exploded, and the suspense had done the work. The effect of the reaction was great. It was hard to get such a community to listen again to anybody proposing a beet-sugar factory for the town, no matter what merit the proposition had.

Some of our factories, however, resulted from the work of the town boomer, and most of them have fully realized every prediction, whether honestly intended or not. Towns of several thousand inhabitants have been built up through the combined influence of the sugar factory and irrigation in the short space of one or two years. They show every evidence of permanence and prosperity. It must be evident, however, that in some places town-booming methods are ill-advised in establishing a sugar factory.

ATTEMPTS TO USE OLD MILLS.

When it became evident that we were to build in the United States a considerable number of sugar factories, there appeared on the scene agents who were in the business of hawking about old mills from one place to another and unloading them on innocent, unsuspecting communities. After such a mill had thoroughly demonstrated its uselessness and the seller's commission had been paid, it was ready to be taken on to some other point and disposed of again. At least three of these migratory factories found their last resting place in the United States. So much traveling permanently disabled two of them, and with the other an additional expenditure equal to its original cost of installation was necessary to modernize it and make it available, efficient, and useful. Of the whole number of factories that have been built in the United States in the last fifteen years, only three have been actually dismantled and disposed of for other purposes, and two of these were the ones mentioned above. Two other factories have been removed and installed in new places, where they are doing active work to-day under more favorable conditions.

LACK OF EXPERT FACTORY OPERATIVES.

A factory is working at its best advantage when everybody connected with it, from the day laborer in the beet sheds, who shovels the beets into the sluice ditches, to the superintendent of the factory, understands perfectly his part of the work. In such a factory the work goes on like the running of well-oiled machinery. A certain quantity of beets comes into the washer hourly and regularly. The power is regulated exactly to meet every demand of the factory. Everybody does his particular part of the work in the right amount at the right time, and he does it intelligently. All are in a sense experts.

When the sugar industry started in this country, we had no experts except those imported. We were dependent upon foreigners. After a while we had, in addition to these, a small supply gradually educated in our factories. It is clear that every new factory had to start with a minimum of experts. Comparing the work of our factories to-day with that of a few years ago, it must be apparent that there is a vast improvement. Even at present the older factories are not able to hold their full force of trained laborers on account of new factories coming into operation, thus affording opportunites for promotion of those having experience in beet-sugar making.

A laborer requires other qualifications than expertness. As a rule he must, to some extent, supervise others, or work in conjunction with them. If foreign, he is deficient in the language and in a knowledge of the customs and habits of the country. He may be an adept in his own country, but here is to some extent disqualified because of those deficiencies. It is found much more desirable that expert laborers should thoroughly understand the language, customs, habits, and conditions of our own country. Foreign experts may, of course, gradually acquire these qualifications.

As an illustration of this necessity for intelligent cooperation among factory operatives, attention is called to the following facts: For general consumption the American demand is for sugar of a different grain from that commonly used in Europe. Sugars for fruit preserving and confectionery may be different from those for table use or from each other. While all our sugar mills are catering to the American market, they may also be catering to a specific market for a particular kind of sugar. As the graining of sugar is governed by the joint action of several people in the process of its manufacture, intelligent cooperation throughout the factory is required from start to finish in order to produce a good grade of the kind of sugar desired.

LACK OF COOPERATION AMONG BEET-SUGAR MANUFACTURERS.

Business harmony in the conduct of affairs is a prime necessity in every enterprise. The lack of it in the building up of the beet-sugar industry has been pronounced. To suggest the cause, I have only again to call attention to the enthusiasm, haste, and confusion incident to the establishment of many factories. The men conducting large enterprises such as these should have a full understanding of the needs of the industry and should cooperate in order to secure the desired results. In many respects the interests of all beet-sugar factories are the same. Questions like that of markets, of transportation, and of legislation demand unity of action. This can only be secured through a unity of feeling and hearty cooperation. That there has been general lack of harmony in this respect is a matter of history. This has probably been due, more than anything else, to the general cosmopoli-

tan training of the men who entered into the financing of this industry. Men are the creatures of their environment and training. Different kinds of business require different methods. A man is prone to use the methods which have brought about the success of his life.

Back of the installation of every sugar factory is a history of its financing which is peculiar to the conditions of its own vicinity. The business trend of each was naturally governed by the men who installed it. They represented many callings—bankers, lawyers, lumbermen, large landholders, stock feeders and breeders, sugar refiners, churches, steel constructors, glass producers, brewers, and distillers. The managements of these factories adopted methods peculiarly their own. They started actively into the fields to establish a career of usefulness and success, each along its own lines.

It took a few years' experience to bring these factory people together on common grounds, to make them appreciate that "In union there is strength," and to teach them that there are a few things peculiar and necessary to the beet-sugar industry, and best accomplished through better understanding and cooperation. The proceedings of the National Association of Beet-Sugar Producers at its last meeting, held in Washington in May, 1904, thoroughly demonstrated that there has been established better harmony of feeling, better understanding of the problems involved, and cooperation more thorough and effective among the producers of this product.

INSUFFICIENT CAPITAL.

In view of the many difficulties to be met by a factory in working out the pioneer problems of a new industry many of the plants were insufficiently capitalized. In many cases only sufficient to bond the enterprise was paid in. It started in debt and with a minimum working capital. To maintain this it depended largely upon the sales of its finished product, which it was compelled to sell as fast as produced, regardless of the market or anything else. When such a factory had to meet unanticipated difficulties one after another, it became crippled, legally involved, and led a precarious existence. Its case was similar to that of a man whose system is run down, and who consequently becomes subject to the attacks of disease germs of every kind and is finally incapacitated for active duty. Heroic methods are required under such circumstances. Some of our factories have been compelled to reorganize, recapitalize, and strengthen themselves to meet conditions such as I have just described.

LOW PRICE OF SUGAR.

In addition to many other difficulties encountered, our sugar factories until recently had to dispose of their product at a low price and under severe competitive conditions. This situation resulted from

natural causes, being largely due to the overproduction of sugar in Europe. Sugar production and markets there were based on very unnatural and peculiar systems. Those countries paid large bounties for sugar exported. In order to secure the money to pay the bounty they practically exacted a consumption tax. In the first place, they put up a prohibitive tariff of 4 to 5 cents a pound on imports of sugar. This prevented importations. The Government then collected from each factory a tax on all sugar sold for local consumption. Out of this excise tax the Government was enabled to pay the manufacturers a large bounty for sugar exported; that is to say, through this give-and-take system it made the people pay large sums of money on sugar exported to other countries. Sugar sold at retail in those countries at 10 to 12 cents per pound. The exporters of sugar could bring that sugar over here under the encouragement of this bounty, pay our tariff of $1.68½ per 100 pounds, and place it on our market at a very low price.

Of course the real profit to them was in selling sugar to their home consumers, and each one of them vied with the others to produce as much as he could for his home market. They were enabled to hold the price up to the highest point not prohibitive to consumption. Whatever of surplus was produced for which there was no demand at home was exported, received this bounty, and was dumped on any market where it could find a customer. Much of it came to this country.

This unnatural system became so burdensome to the people, the governments, and the manufacturers themselves, that all the European countries engaging in it except Russia united in a conference at Brussels, their representatives entering into an agreement, which was indorsed by their respective governments, to do away with the bounty system. In name the bounty system has been abolished. In effect there is still more or less of the system in use, through hidden devices of the various countries seeking to accomplish the same through other means.

This has brought about more or less diplomatic representation between those powers. Gradually they are unearthing the roots of the old system and digging them out. It seems probable that they will be destroyed altogether. Suffice it to say, sufficient has occurred in this direction to produce good results in the markets of our country; our factories are receiving better and steadier prices and conditions seem to indicate that these better market conditions will continue for some time. The European countries referred to are gradually reducing their plantings and contracting their exports.

DEVELOPMENT OF CONDITIONS AND PROSPECTS FOR NEW FACTORIES.

During the last year four large factories were installed in new locations, two in Wisconsin and two in Idaho. One of these factories is new, while the other three are old ones removed from locations where they had not thrived. At the present time there are at least twelve factories proposed for the different parts of the country, the parties interested having effected organizations, raised capital, selected sites, made contracts with farmers, and announced that the factories will be in operation during the campaign of 1905.

In my former reports I have had occasion many times to mention the influence the beet-sugar industry is exerting for development along all other lines in the States where it has been established. Throughout the districts having factories, railroads are being built, some of them equipped with rolling stock constructed especially to transport the beets, the sugar, the fuel, and other crude materials used in the manufacture of sugar. At the same time trolley lines are being constructed. Live-stock feeding interests are becoming greatly increased; dairies and creameries are being established to utilize the by-products of the sugar factories.

Where the cultivation of sugar beets has obtained to any great extent there is a very noticeable improvement in all agricultural methods. A farmer growing sugar beets for a few seasons becomes accustomed to intensive methods, and as he realizes the benefits he applies such methods to everything else cultivated on the farm.

LOCATING NEW FACTORIES.

Great care is now exercised in selecting locations for new factories. The four factories established this year were located in communities having considerable experience in growing sugar beets, not experimentally, but for factory use. The factories proposed for next year are all to be located in places where all the conditions for growing sugar beets have been thoroughly tested. Experience teaches that it is not only necessary to test the soil, but to investigate the demands and requirements of the particular districts. It is especially desirable to ascertain the disposition of the farmers and the character of the industries with which the industry must come in competition. There appears now to be a tendency to locate new factories in districts where the production of other special crops is not highly developed.

Several of the new factory projects involve industrial development along other lines, such as irrigation, dairying, and stock feeding, which will be more or less dependent on the sugar factory. Many of the new companies have purchased large bodies of cheap land. The object of this step is twofold: (1) It puts under the control of the factory the

area of land which will guarantee at all times a sufficient supply of beets; (2) it affords an opportunity for good investment, as a rise in the value of lands may be expected as a result of the establishment of the factory. In order to use the arid districts, irrigation is necessary; consequently, considerable investment of capital in irrigation is necessary. These lands will be held and cultivated in a body for the benefit of the sugar factory. After the conditions have been thoroughly developed and the industry established, they will be divided into smaller tracts, and rented or sold to beet farmers for use in raising sugar beets. Whatever the purpose, experience has proven that this policy will be very beneficial. Growing of sugar beets will be the main employment of the community. The work will begin with the early development of the resources of the district itself; beets will not have to be grown in direct competition with established crops. When the time comes for introducing such other crops, the beet crop will have made its own record and established that permanency of beet supply upon which the sugar factories depend.

The past year has witnessed the moving of a few factories not favorably situated to better locations. Attention has already been called to the various obstacles to the success of sugar factories, viz., the attitude of the farmers, unfavorable soil, irregular weather conditions, competitive crops, etc. While these obstacles have not affected seriously a great number of the factories, they have individually or collectively operated with sufficient potency to stop the wheels of six factories. Of the four plants installed this year, two were previously operated in other places in this country: (1) The factory at Binghamton, N. Y., was moved to Blackfoot, Idaho; (2) the one at Kalamazoo, Mich., was moved to Chippewa Falls, Wis. The factory established at Janesville, Wis., this year, was moved from Dresden, Canada. The factory at Norfolk, Nebr., the property of the American Beet Sugar Company, is now being moved to Lamar, Colo. In these cases and others, where removal is proposed, the factories have been, or will be, improved and placed in districts with conditions better fitted for furnishing them a supply of beets.

It is only fair to state that the unfavorable conditions causing the removal of these factories were not necessarily fatal to their successful operation where they were. It is the opinion of those best advised on the subject that their difficulties were not insurmountable; that in time good management would have overcome all the obstacles ahead of them. Those who were financially interested, however, reasoned in this way: "There are a great many places in this country adapted to the industry, where the difficulties in the way of success are far less. Is it not wiser to take advantage of these and pay the cost of removal than to struggle along or lie idle for an indefinite time?" There are two or three other plants in the United States whose managements have

been contemplating the same thing. Hence, we may have two or three removals next year or the year following. When this is done we will have closed the corrective work of locating factories up to date. Locations are now based on better information; the conditions of the country are better understood.

SUPPLY OF LABOR FOR FACTORIES AND BEET FIELDS.

There has been marked improvement in the character and supply of labor. When a sugar factory starts its first campaign it employs from 200 to 400 persons in its work, the number depending on the size of the plant and conditions peculiar to it. A number of these will be unskilled workmen, performing the ordinary manual labor around a concern of this kind, viz, shoveling beets, fuel, lime rock, etc.; others will be employed in work more or less skilled. The wages for skilled laborers range from $2 a day up to $5,000 or $6,000 per annum for the superintendent. For the lowest group of laborers I have used the term "unskilled;" but, at the same time, as between first experience and that after becoming accustomed to the work there is a vast difference in the efficiency of such labor. To an extent, all of the workmen around a sugar factory are skilled. Advancement or promotion goes on all along the line, except possibly in the technical departments, such as chemistry, etc., where strictly technical scientific training is required. In a sense, the sugar factory is a school fitting men to accomplish its work.

As already stated, in the beginning all the experts employed had to be imported. Since the establishment of the first factory, at Alvarado, Cal., we have been fitting men for this work. The volume and efficiency of labor has been growing constantly ever since. While it is best for a factory to hold on to its old employees, it can start a certain number of new men each year without serious consequences. This it will probably have to do if some new factory requiring expert workmen tenders positions to some of its trained men at higher wages. Consequently, there is still large room for improvement in the supply and quality of our factory workmen.

The question of developing and maintaining the supply of laborers for the beet fields is of equal importance and is certainly a much larger problem. The minimum number of laborers around an ordinary factory is about 200. For such an establishment the number of farm laborers needed in its territory for growing sugar beets, not including the farmers themselves, will be from 800 to 1,000.

As in the case of the laborers in the factories, we had no trained men to begin with. The deficiency was even more pronounced in the field than in the factory. Much of the work in the factory could be done by persons who had been trained to do similar mechanical work in other lines of industry. But the great problem that confronted

capitalists contemplating the building of factories and the managements of factories actually established was: "Where are we going to secure the labor to grow the beets?" It certainly was the hardest problem they had to solve. As indicating the effectiveness of its solution and suggesting its future development, I will outline the present procedure in securing supplies of labor for the fields tributary to the factories now in existence.

Living in cities there is a class of foreigners—Germans, French, Russians, Hollanders, Austrians, Bohemians, etc.—who had had more or less experience in beet growing in their native countries. Their experience had been largely agricultural. Emigrating to this country, they had congregated in cities and towns, and were performing the work of ordinary laborers on public works, on railroads, and in various other lines of employment. Their attention was attracted to this industry when it started—old to them, new to us. They naturally sought this new avenue of employment. It appealed to them for two reasons: (1) They could secure employment in work to which they were accustomed and in which they were expert; (2) in the beet fields they could find work for their whole families. In this respect it differed from other lines of work. The head of the house could go out and dig in the trenches of the city, or work on the sections of the railroad, or in excavations and other kinds of employment under a contractor. The women and children of the family could not do this. Growing sugar beets was a renewal of their former experience. For the work of the beet fields more came from the cities each succeeding year, and others came from Europe, induced by the news of the installation of this new industry. They could secure immediate employment of the kind to which they were accustomed. This source of labor supply for our beet fields has grown to a wonderful extent. Every spring sees large colonies of this class of workmen moving out from our cities into the beet fields.

There is another class of foreigners, not previously experienced in growing beets, who readily adopted it on account of their natural adaptability to the system. As a class, they are accustomed to hard drudgery work of any kind, spending their lives during their stay in our country in work on public improvement, railroads, large contracts, etc., requiring hard manual labor. In this class come the Scandinavians (a few of whom have grown beets), Italians, Japanese, Chinamen, Portuguese, etc. Large numbers of these, annually increasing, take contracts in the beet fields. All these foreign laborers, of whatever class, live in tents, barracks, and other temporary abodes. They board themselves, and grow sugar beets under contracts with the farmers. It is rulable in such cases for the work to be done by the acre. The farmer plows the ground, harrows it, puts the seed bed in thorough condition, plants the beets, and does all the necessary culti-

vation requiring horses. The contracting laborer does all the weeding, bunching, thinning, hoeing, irrigating, topping, and loading, usually receiving for the same from $15 to $20 per acre. The farmer does the work of plowing up the beets and delivering them to the factory. Foreigners of this latter class were originally more or less unsatisfactory on account of unfamiliarity with the work. After five or six years, most of these workers in the beet fields are efficient. The additional hands accompanying them each year have the advantage of association with those acquainted with the methods, and become satisfactory workers more readily than otherwise. To this class we are also procuring large accretions every year, thus augmenting the sources of labor supply of sugar factories and sugar-beet growers.

Philanthropic societies and eleemosynary institutions are also gradually aiding in this respect. One of the strongest addresses made before the Trans-Mississippi Commercial Congress at its meeting in Seattle, Wash., last year was that of Commander Booth-Tucker, the head of the Salvation Army in this country. In this address he explained the policy maintained by that society of finding employment for everybody coming under the army's influence. The beet fields appealed especially to him in this connection. He proposed colonization from our larger cities, using the beet fields as means of reformation and employment. The plan as he represented it greatly impressed all who heard it. As a matter of fact, considerable has been done by this organization along this line. It is also quite common for the humane societies, associated charities, and other like organizations of our cities and towns to procure, for those dependent upon them, employment in the beet fields.

Our State reformatory institutions and asylums are also developing an interest in the work of growing sugar beets. One of the great problems of such institutions is to keep the inmates employed; in so doing it sometimes happens that they come in conflict with the rules of organized labor. Possibly if the supply of labor for the beet fields exceeded the demand the same objection might operate here. Under the present circumstances it does not appear to be deleterious to regular labor. If these people can be employed in rural pursuits it will have a tendency to strengthen rather than to hurt labor in regular lines.

Our cities and towns are constantly increasing in importance as sources of labor for the beet fields. Every year sees more and more of the unemployed seeking the beet fields for remunerative work. In this respect we are developing a practice similar to that which prevails at harvest time. Most people are familiar with the movement of laborers annually taking place from south to north, following up the grain harvest as it progresses with the season. Harvest hands pour into the South with the ripening of the grain, gradually working

north as the work is completed, finally winding up with the harvest in Canada. This custom has developed the class of laborers known as professional harvesters. Similarly we are developing a class of beet growers, who move toward the fields on the approach of the beet season. To this class are continually added recruits who in a season's experience become more or less proficient.

Our beet fields are also the beneficiaries of another class of labor possibly more abundant, and at the same time adaptable to this work. In the cities and towns public schools close about the time the active work begins in the beet fields. Considerable attention is being given to directing this kind of labor to beet growing. It is a matter of consequence and one fraught with valuable training to the unemployed young people of the country. Ordinarily there is very little that a boy can find to do during his school vacation. It so happens that the beet fields offer active remunerative employment for this particular period. This work serves a twofold purpose: It gives a boy self-support to a degree, and relieves the head of the family to that extent; it also lessens the work of charitable institutions. At the same time it inculcates habits of industry and frugality, removes the boy from the temptation of idleness and the school of vicious habits constantly in session in the streets of our cities and towns. It promotes health, physical strength, and vigor. It inspires confidence and self-support. This applies not only to the poorer classes, but to all boys who otherwise would be idle.

Keeping the boys of the cities and towns employed, especially those who are drifting into the classes of chronic idlers and criminals, is one of the social problems of to-day. During the past few years agitation on the subject has crystallized into a policy of establishing juvenile courts. (See page 147.) Idleness is the most prolific of all causes producing the two classes named. The work of these tribunals contemplates segregation and useful, healthful employment under supervision. Several States have enacted laws establishing such courts, and relegating to them cases of juvenile offenders. Such a court has regular officers, who list boys liable to its supervision. Such cases as come before it regularly, it places under the care of its officers, who direct them to some field of active employment. In districts having sugar factories, the beet fields have been playing an active part in this species of education and reformation. At first the plan did not prove very satisfactory. These boys, in groups or individually, were hired out to farmers, who found themselves without authority, and as a rule without disposition to exact of this class of workers faithful performance. In most instances the boy was soon back in his old haunts. During the past year a better system involving closer supervision was maintained. The boys were sent out in groups, with their probation officer over them. This officer was

clothed with full authority for maintaining discipline and executing the demands of the court. A group usually consisted of 20 boys, who formed a club, all sharing equally in the expense. A cook was hired who prepared all food. Contracts for the group were made by the officer; he was present at all times to maintain discipline and the faithful performance of the contract. The money earned by each boy was paid over to the court and credited to him after deducting his share of expenses. Under this system juvenile court work in the beet fields was much more satisfactory.

It is plain to be seen that, through these various sources of labor for our beet fields, conditions at the present time are very much improved. Whatever the source of supply of labor, it is constantly increasing and improving. Under the circumstances I should say that the labor problem of the beet-sugar industry is adjusting itself as rapidly and satisfactorily as any other feature of its development.

BETTER COOPERATION AMONG THOSE INTERESTED IN THE BEET-SUGAR INDUSTRY.

There is closer and better cooperation between the factories and farmers, as well as among the factories themselves. There were many things that led to contention between the factories and farmers. One of these was the question of tare. The amount of tare varies widely, depending upon the condition of the beets delivered to the factory. This again is dependent upon the kind of soil producing the beets, and upon the condition of the soil when the beets are harvested. In clay soils dirt is more liable to adhere to the beets than in sandy loam; and more dirt adheres when the ground is wet and muddy than when it is dry. Neighboring farmers may deliver their beets at different times or they may have different kinds of soil. One farmer's tare may be high and another low. Every farmer's tare is known to every other farmer in the district. Those who have high tare feel dissatisfied. But there is no place to settle the question except at the scales of the sugar factory. Experience is doing away with a large part of this controversy. Everybody concerned has more adequate ideas of the things affecting tare. Farmers find that while they have low tare one year it may be high the next; that natural conditions govern these things.

Many of our farmers have had contracts providing that payment for beets be made on a "sliding scale." It is customary to establish as the standard of quality for the beets a sugar content of 12 per cent and a purity coefficient of 80. For this the factories pay a certain minimum price. Beets of higher sugar content and purity command a higher price. All beets are tested as they are delivered at the sugar factory. A sample is taken from each wagonload or carload, thoroughly washed and reweighed, the resulting loss in weight being the tare. A tag is

attached to each sample, and on it are recorded the results of the various tests. After the tare has been ascertained the sample is then handed over to the chemist of the factory, the juice is extracted from the beets, and a test of its sugar content and purity is made. From the data on the tags records are made up in the bookkeeper's office. These records of tare and average contents and purity of the beets are used in computing the amounts due the farmers. Payment may be made once a week, or once a month, or when the farmer has delivered all his beets.

Under this system there is a wide divergence between the highest and the lowest prices paid to the farmers of a particular community. Sugar contents and purity, like tare, are largely dependent upon circumstances. They are especially dependent upon the way the beets have been treated during the growing season, the kind of soil, its previous use, the preparation of the seed bed, the bunching and thinning, the cultivation, etc. At first it was difficult for the farmer to see why his beets should not rank as high as those of his neighbor. He felt himself at the mercy of the sugar company in this respect. As to the factors controlling quality in beets, after growing them year after year, he is becoming better informed. He has discovered that the quality grows higher as he applies the proper methods. Farmers more generally apply these methods now, and, as a result, they are producing better beets. As a rule the factories and the farmers are gradually getting nearer together, and are cooperating with less friction.

As the improvement of beets produced for our sugar factories proceeds and they become more uniform in character, there is a general tendency to abolish the "sliding scale," and to pay a higher "flat price" than formerly.

Factories are more methodically cooperating with each other in all matters pertaining to the general welfare, viz, legislation, markets, transportation facilities, tare, crop districts, etc.

In some places factories were installed with capacities beyond the pioneer resources of the district. Among the factories in such districts there has been considerable controversy as to the legitimate territory belonging to each. Farmers would contract with one factory and deliver beets to another. The first factory would then replevin the beets under the contract; this would be followed by litigation, losses on account of holding the beets, etc. Such things have compelled a better understanding among all concerned.

In the methods of some of our early factories there was a tendency to carry on the work behind locked doors, and to throw an air of mystery around the operations. But at present there is hardly a sugar manufacturing company in the country that will not have shown through its establishment persons or groups of persons engaged in

honestly investigating this industry. Whether investigating a particular feature of the work, or the sugar industry in general, such visitors are given every aid.

The proprietors of factories are cooperating in securing more equitable rates from railroads, better arrangements with commercial distributors of their products, a better appreciation on the part of the public, and a more systematic encouragement on the part of the press.

They are planning and executing needed improvements in their factories, they are making more systematic efforts to secure high-grade beet seed for the farmers, and they have succeeded in establishing closer harmony between the factory agriculturist and the beet growers. In inspecting and selecting the land which it is proposed to devote to beet culture, these agriculturists have become better informed as to the nature and condition of the soils with which they have to deal, and they more easily induce the farmers to follow their directions. Consequently better cultivation is secured, and there is a growing tendency to systematic fertilization.

Mention will now be made of the new projects contemplated for the future, with a review of the conditions prevalent in the localities selected, so far as investigations have indicated the same.

CALIFORNIA.

California was not only the early home of our beet-sugar industry, but it has made steady progress, and, up to the year 1904, it has held the first place as a beet-sugar-producing State. Colorado, however, produced more sugar this season. The State of Michigan has in the aggregate a factory capacity for producing more sugar than California, but it has not done so up to date.

The factories of California are very large, some of them among the largest in the world. The beets grown in the State are very rich in sugar; conditions in the State for producing sugar are more settled and have been longer under development.

In earlier reports I have outlined to a considerable extent the many advantages of the State of California for the development of this industry. It is estimated that the people of California, Washington, Oregon, and adjacent mountain States consume annually something like 100,000 tons of sugar, thus making a large and convenient market for the product of the factories. Formerly most of the sugar produced in the Hawaiian Islands went around the Horn to the Eastern refineries. About 50,000 tons were shipped to San Francisco, refined, and distributed to the market above mentioned. California supplied the rest. This situation did much to encourage the industry in California in its earlier stages. The development of the sugar industry in the intermountain States has curtailed to some extent the territory originally supplied by California. The annexation of Hawaii to the

United States has also had a tendency to bring more of the sugar manufactured there to our western shore. Consequently the development of the sugar industry in the State has not proceeded so rapidly in recent years.

In California the beet-sugar industry has developed on somewhat broader lines than elsewhere in the United States. Like other agricultural and horticultural industries it has received the united support and loyal sympathy of all the people of the State. These people were early accustomed to seeing things run in a large way. The State had immense forests, which were soon denuded by large lumbering companies; mining was conducted on an extensive scale; large ranches were in vogue, containing from 5,000 to 20,000 acres each. These were first utilized as sheep, cattle, and horse ranches; finally, many of them were plowed up and sown to grain. It was not uncommon to see fields of thousands of acres harvested with immense reapers and the grain thrashed and sacked in the fields as it was harvested. Even to-day the same methods obtain to a greater or less extent.

The introduction of intensive agriculture had a tendency to cut down these large holdings and substitute smaller. It was possible for capitalists in combination to purchase these large tracts and cut them up into smaller holdings better adapted to intensive uses, such as growing fruit, potatoes, beans, and the like. Then came the establishment of the sugar factory and the growing of sugar beets. Sugar production and fruit production have been mutually helpful. There has been a very rapid development in fruit production in California and the intermountain States, which has occasioned a constantly growing demand for sugar for use in fruit preserving.

The rainfall of California was sufficient for the system of agriculture prevalent in early days. With the advent of such industries as the growing of fruits and sugar beets more water became necessary. This encouraged the building of irrigation ditches, supplied by tapping the running streams, and later by reservoirs, built for storing water for summer supply, and finally the sinking of artesian wells to secure additional supplies of water. Through irrigation the State has increased her arable lands and developed resources for future extension.

A number of new sugar-beet projects have been under contemplation in the State for some time, one of which has received considerable attention during the past year.

There are many beautiful, fertile valleys in the State of California, some of which have reached a higher state of agricultural development than others. The process of evolution, as already indicated, has been from large ranches used in grazing sheep, cattle, and horses, to grain fields and, finally, to the smaller farms growing fruits, vege-

tables, sugar beets, and the like, the last stage of development generally involving the use of irrigation.

Probably one of the most admired of all great valleys of California is the Sacramento. The Sacramento River has its source in Modoc County, in the northeastern corner of the State. It drains the great valley bounded by the Sierras on the east and the Coast Range on the west, which extends through the upper third of the State. This valley has been the subject of constant investigation ever since the sugar industry started in the State. Its great productive grain fields, stretching on either side of the banks of the Sacramento, have been a constant source of interest to those contemplating intensive agriculture.

The Sacramento Valley Development Association is one of the most active bodies in the State interested in the development of its resources. This association is constantly studying the resources of this valley, sending out literature, exhibiting its products, and attracting capital to the development of its many resources. During the past year it installed at the Louisiana Purchase Exposition an extensive exhibit of the resources of the valley, and it constantly maintains such an exhibit at Los Angeles and San Francisco.

Through its efforts many places are suggested as adapted to the production of sugar beets and the establishment of beet-sugar factories. Chico, Marysville, Jacinto, and Colusa are contemplating such projects.

COLUSA.—Among those interested in the establishment of sugar factories in this valley is Mr. G. S. Dyer, of Alvarado, Cal., who grew up in the sugar business. He started in the old Alvarado factory, under the management of his father, many years ago. He has superintended several sugar factories in different parts of the United States and Canada at different times. Associated with other gentlemen, Mr. Dyer has been giving the resources of this great valley careful study during the past summer. This study has resulted in the determination to build at Colusa. The company organized is known as the Colusa Sugar Company, capitalized for $500,000. Stock has been subscribed, contracts made with the farmers, and every arrangement made to establish a sugar factory at this place this year to be in operation for the campaign of 1905.

W. A. Beard, secretary of the Sacramento Valley Development Association, in his report to that body in September, had the following to say touching the conditions of the Sacramento Valley and the proposition for the beet-sugar factory at Colusa:

BEET-SUGAR FACTORY.

In the matter of the proposed beet-sugar factory at Colusa, I am able to report that a strenuous effort is being made to bring the matter to a successful conclusion. There are very considerable difficulties to be surmounted, but we hope for success.

Before coming to Colusa to take up the matter of acreage contracts, which I have done as authorized at the last meeting, I visited four of the seven beet-sugar districts of this State. Without going into detail, I will state that I returned from this trip fully satisfied that sugar beets will do well in the Sacramento Valley and prove a crop of very great value. I found sugar-beet land valued at from $125 to $300 per acre. I found that renters who secure crops of from 10 to 18 tons to the acre pay one-fourth rent, giving a return to the land owner fully justifying these valuations. I met men who have become well-to-do growing sugar beets on rented land; and from bankers and business men I secured expressions fully warranting the conclusion that sugar beets are a good crop. The importance and value of the introduction of this crop into the Sacramento Valley will certainly warrant the most strenuous effort on our part to assist the people of Colusa in securing the proposed beet-sugar factory, and I trust the work being done by myself as your representative will meet your approval.

OTHER INDUSTRIAL ENTERPRISES.

In this connection I will say that I believe our association can perform a very great service to the Sacramento Valley by aiding in establishing enterprises of the larger kind, thereby providing markets at home for the products of farm, orchard, and mine, providing employment for workers and adding to the general prosperity. New enterprises that are springing up in the Sacramento Valley and watershed are among the most encouraging signs of the time.

Chief among these, and most far-reaching in importance, are the irrigation enterpises that are just now attracting widespread attention—the central irrigation canal in Glenn and Colusa counties, the Butte County canal in Butte and Sutter counties, and the new irrigation system in Yolo County. Two beet-sugar factories and numerous small enterprises are in contemplation. In the mountain districts mineral deposits other than gold are attracting greater notice than ever before. Asbestos has lately been shipped from an Eldorado County mine.

Gridley, in Butte County, and Winters, in Yolo County, are planning big demonstrations, the former in honor of the beginning of the work on the Butte County canal, the latter in honor of the completion of the Yolo consolidated ditch.

COLORADO.

For rapid thorough development of the beet-sugar industry Colorado takes first rank. Beets are grown almost entirely by the aid of irrigation. Although more or less rain falls during the growing season, whatever additional moisture is required is furnished in this way. In this State can be found more advantages for growing sugar beets than in any other in the Union. These generally favorable conditions have redounded greatly to the quick and successful development of the sugar industry. At the same time the new industry has done much for the general advancement of the other industries of the State.

Colorado has greatly developed storage systems upon which further extension of irrigation must depend. Prior to the advent of the sugar industry irrigation was mostly supplied from running streams. Throughout its whole expanse the State has superior qualities of soil adapted to growing sugar beets. Given sufficient water, it can produce more beets to the acre, and of better quality, than any other. Where the beets are properly cultivated and irrigated a tonnage of

12 to 25 tons is readily secured. In European countries, where methods of cultivation have reached their highest development, an average of 14 per cent sugar in the beet and 13 tons of beets to the acre are the maximum figures. The factory districts of Colorado, with their short experience, have attained a higher tonnage per acre, and produce beets averaging from 15 to 17½ per cent of sugar.

There are many mining districts in the State, interspersed with rich agricultural valleys. These mining districts form the nuclei for municipal organization and development. The valleys are watered by irrigation, reclaimed by cultivation, and made resourceful in crop production. Formerly they were used largely for grazing. Rapidly they have become more useful in intensive agriculture. The agricultural valley and the mine are to an extent complements of each other. The mines and smelters accumulate capital, build up the towns, and develop commercial advantages; the beet husbandry intensifies the agriculture of the valleys, builds railroads, trolley lines, and irrigation ditches, and feeds the community at large. Other incidental advantages follow, induced by more dense population in the valleys.

Colorado has many laborers delving in the strata of the earth extracting Nature's deposits, and many others sweltering in the smelters, refining these metals for general use. The cost of living of both of these classes was originally high, because supplied by neighboring States farther east. They now look to their own valleys for sustenance. They have supplanted the wild horse and the grazing steer. The sugar-beet industry is the central factor in making possible this great advance—a fact clearly demonstrated and recognized by all interests in Colorado.

As evidence of the public recognition of the importance and rapidity of development of the sugar industry in Colorado, I insert here a clipping from the Colorado Springs Gazette of November 26, 1904, which is as follows:

The beet-sugar season now under way promises to be the most profitable since the beginning of the industry in this State. The farmers and factory workers will receive more money for their product and labor, and the quality of sugar is said to be superior to that of any other season.

The running expenses of the six factories in the northern part of the State will be $50,000 a day, or $5,000,000 for the season of one hundred days. It is estimated that 350,000 tons of beets will be handled, which will yield 77,000,000 pounds of sugar. These figures pertain only to the factories in the northern part of the State. Those in the southern district, being fewer in number, have a smaller capacity, but it is believed that they will pay out about $2,000,000 more, making a total of $7,000,000 which the farmers and factory workers of Colorado will receive this season for the sugar-beet harvest.

The rapid growth of the beet-sugar industry in Colorado is one of the most remarkable developments in the agricultural life of the West. It is only about six years since the first factory was built, but the value of the output has grown from nothing to $7,000,000 last year, and it will probably be considerably greater this season. The

soil and climate of the eastern half of the State seem to be peculiarly adapted to the culture of sugar beets, and it is an established fact that the percentage of saccharine matter contained in Colorado beets is greater than in those raised in other sections of the country.

The yield to the acre being larger than that of any cereal, makes it possible for the farmer to cultivate a small farm with greater profit than he could a larger tract devoted to wheat, corn, or oats. This necessitates more thorough cultivation, and also provides opportunity for a larger and more prosperous population to the square mile. Irrigated sugar-beet farms may yet transform eastern Colorado into one of the most densely populated agricultural regions in the country.

Throughout my reports I have often called attention, where the lands are sufficiently watered, to the extensive agricultural resources of Colorado; also to the adaptability of the sugar industry as a means of developing the more arid portions. Its demands are extensive. It must necessarily capitalize on a large scale if it employs facilities, such as irrigation, transportation, etc., necessary for its successful operation.

I have always insisted that the sugar beets require good companionship, succeeding best where conditions favor a varied agriculture. This crop gives the best results with average farmers when grown in rotation, and on small fields rather than large. Their intense cultivation leads to improvement of the soil both in fertility and mechanically.

In agriculture Colorado began with grazing. She has gradually developed the production of alfalfa, small grains, potatoes, fruits, and melons. There has been a remarkable increase in these things, due to growing sugar beets, as well as a stimulation to a wonderful extent of cattle feeding, breeding, and dairying. We see daily in the public press extensive reports from sugar-factory districts concerning the installation of these new industries.

The recognition given to these things in our public press is suggestive of their importance. Some of the best newspaper writers in the country conduct investigations of these things, and give "write-ups" of their observations. As an evidence of the influence of the sugar industry and the magnitude of the same, I insert the following from that veteran newspaper reporter, William E. Curtis. This article resulted from a careful study of conditions in the beet fields of Colorado, and was published in the Chicago Record-Herald, November 24, 1904:

OPERATIONS ON A LARGE SCALE.

Last season (1903) the Rockyford factory paid more than $600,000 for beets to the farmers in the neighborhood, 110,000 tons being brought in by rail and about 20,000 tons by wagon. Its freight bill to the Santa Fe Railway alone was more than $300,000, as it buys the beets at the track and pays the expense of handling them. The business has grown so large that the railway company has built elevated tracks and chutes, similar to those used for handling coal, at every station and at other convenient places. Now the farmer has only to drive his team up an incline to a

platform and pull out the end board of his wagon, so that the beets may slide down into a coal car.

Last year the Rockyford company shipped about 300,000 bags of sugar, each weighing about 100 pounds. It is all bought by the sugar trust, and the prices are regulated in New York.

Everything connected with beet farming can be done by machinery except weeding and thinning the plants and picking up the beets. The seed is sown with a seeder; the weeds between the rows are kept down and the soil is kept loose by cultivators; the beets are dug by horsepower; but so far human ingenuity has not been able to provide any device for weeding among the plants or thinning them out where they are too thick. That has to be done by the hands of human beings on their knees, and it is the great drawback to the industry. The independent American citizen will not spend the day on his knees, and he will not allow his wife or daughter to do so; hence there is great difficulty in getting anybody to do this back-breaking work. About 600 Mexican and Indian men and women are brought up from the pueblos of New Mexico every year. They come from as far away as El Paso and Gallup in weeding time, bringing their women and children, and stay until after the cantaloupes are picked and shipped, about two months altogether, and are paid from $5.25 to $7.50 an acre for weeding and thinning beets. A Pueblo Indian or half-breed Mexican, with his wife and children, can do from one to three acres a day, according to the size of the family and their industry. The sugar company sends out agents in the spring to gather them up, pays their railway fares, and provides quarters for them to live in.

IMMENSE IRRIGATION SYSTEM.

Behind the Rockyford factory is one of the biggest irrigating systems in the United States, owned by the Arkansas Valley Sugar-Beet and Irrigated Land Company, composed of H. B. Hyde, of the Equitable Life Insurance Company, the Mercantile Trust Company of New York, the Oxnard Brothers, and other eastern capitalists. It has 14,000 acres of reservoirs, 350 miles of main canal and 750 miles of laterals, covering an area of about 120,000 acres, which the company has purchased in small tracts from the railway, the State, and from tired farmers who tried to farm with rain and failed. There are now about 70,000 acres under water, and 25,000 acres more can be reached by the extension of this system.

The next largest plant is the Fort Lyon system, immediately west, which was organized by T. C. Henry, of Kansas, and sold to the farmers after all the land was disposed of. It has about 60,000 acres, watered by 113 miles of canals, divided among about 360 farmers.

The largest irrigated area in one location is on the Platte River, in northern Colorado, but it is operated by a number of independent companies.

The man who started the Arkansas Valley irrigation system made a failure of it, and the property came into the hands of the present owners unwillingly by foreclosure. They had to put in more money to save their investment, and have continued to do so during the last six years, until they have invested several millions in land, ditches, and improvements. They have sold about 30,000 acres, all the way from $40 to $180 an acre, according to location, and that is a big price for raw land with no improvements except water. The lowest price of raw land is $40 an acre; the lowest price at which cultivated land has been sold lately is $60 an acre. Every acre has to pay 50 cents a year for water. * * *

EFFECT OF IRRIGATION.

With irrigation, 40 acres will produce as much as any ordinary 160-acre farm without, and, indeed, the company insists that nobody can profitably handle any larger tract. It will not sell more than 40 acres to any one buyer. There are now about

250 farms within the irrigated district. The largest, 320 acres, belongs to J. C. Moss, who was one of the earliest buyers, and got his land before the property passed into the hands of the present owners. The Salvation Army has 1,700 acres at a town called Amity, upon which it has located a colony of about 400 people. Two other towns, Holly and Granada, are dependent on the company for water.

There is room enough on the irrigated area for a thousand farms and a general population of 10,000 or 12,000. Any staple will grow. Sugar beets are the surest and most profitable, all things considered, and will pay anywhere from $25 to $125 an acre, according to the skill and industry with which they are cultivated. Cantaloupes will pay more, often as high as $250 an acre, but they are a speculative crop and often uncertain in quantity, price, and market. Alfalfa will average better than cantaloupes year in and year out, according to the testimony of the farmers. It is always in demand in Texas, Oklahoma, New Mexico, and Arizona at profitable prices, and requires less labor than any other staple. Apples, peaches, and other fruit pay well, but require five and six years to reach the bearing age. There is a steady profitable market for all kinds of vegetables, and a wise farmer divides his interests and avoids the error of carrying all of his eggs in one basket. He will have a truck garden, an orchard, four or five acres of melons, and give the rest of his land up to alfalfa and beets.

A number of places in Colorado are on the eve of installing sugar factories. Some of them will be in operation during the campaign of 1905, others in 1906. Those with plans more definitely arranged are the following:

BRUSH.—Brush is located near the Platte River, on the Burlington and Missouri River Railroad, and also near the Union Pacific, which runs on the north side of the river at this point. It is about half way between Denver and the eastern boundary of the State, and in a practically new irrigated district. It has shown quite favorable results in producing the usual crops of that part of the State. Its proximity to the factory at Greeley and others in that section has afforded it the opportunity of growing beets for several years. Through this practical method its conditions have been thoroughly investigated, and sooner or later it is quite probable that a sugar factory will be constructed there.

This place was under investigation by two or three different sets of capitalists during the past summer. Its location has been favorable to growing sugar beets for other factories, thus demonstrating its advantages; but this fact has not tended to the immediate establishment of a factory. As in all other factory districts where there are several factories contending for a supply of beets, it takes time to work up the supply of beets to the capacity of all. A location in a competitive district of this kind must bide its time until existing factories are assured of a permanent supply in their own immediate vicinities. Investors may then feel justified in installing an additional factory.

Keeping in touch with the progress and development of such places, I wrote Mr. A. J. Morey, agricultural superintendent of this district, for the latest information up to date, and received the following reply:

BRUSH, COLO., *December 26, 1904.*

DEAR SIR: In answer to your request, I submit a few facts concerning the sugar-beet industry in this part of the State.

In the spring of 1903 there were planted about 1,100 acres of beets in this county (Morgan). The season proved very dry and backward, and we only harvested about 7 tons per acre. The farmers, as a consequence, were discouraged, and it was with difficulty that I managed to contract with the farmers for 300 acres for 1904. The season proved good, with plenty of moisture, and we harvested a crop that averaged 14 tons per acre; 30 tons per acre was the heaviest. Our tonnage was considerably less than it would have been owing to the advent of the tent worm, which made its appearance the last of July and which damaged some fields fully 50 per cent.

The outlook here was exceedingly bright for a large acreage for 1906, and also for a sugar factory here for 1906. The sugar contained in our Colorado beets runs from 15 to 18 per cent on an average.

I hereby append the names of farmers who grew beets the past season:

Brush post-office: A. H. Defpke, D. W. McSween, Nels Christensen, James L. Petersen, H. Hansen, Sam Andreason, William Fick, William Jones, L. M. Davis, C. L. Colwell, Knud Michaelson, R. Madsen, Fred Rasmussen, Nels C. Christensen, J. A. Aspinwall, J. C. Joppa, W. C. Burchstead.

Hillrose post-office: W. W. Sickles, G. W. Sheldon, Jeno Bach, Claus Seviers, Peter Petersen, Fred Wahlert, W. S. Stratton.

Yours, truly,

A. J. MOREY, *Superintendent of District.*

CRAIG.—Noticing considerable comment in the public press with reference to Craig's agitation of the beet-sugar industry, I wrote Mr. J. R. Kilpatrick of that place and from him received the following report:

CRAIG, COLO., *January 2, 1905.*

DEAR SIR: Replying to yours of the 31st ultimo, I will say that as yet very few beets have been raised here, and the data you ask for I am unable to give you. While I have seen some very fine beets here, they are only raised for feed, there being no factory here as yet. Some have been tested, and I am told there is only one place in the State where they test higher. When a railroad reaches here and we complete our canal project we are assured a factory, and no doubt beets will be raised on a large scale.

I have 100 pounds of German beet seed for distribution and will furnish them free to all who care to experiment, so that next year I can give you the desired information.

Very truly, J. R. KILPATRICK.

JULESBURG.—This town is situated in Sedgwick, the northeastern county of Colorado, on the line of the Union Pacific Railroad, and is quite a lively railroad point. Its agricultural district is penetrated by three irrigation systems, viz, the Peterson, the Settlers, and the South Reservation. It has about 40,000 acres available for agricultural production. A liberal supply of beets can be drawn also from the irrigated district in the State of Nebraska, just east and contiguous to it.

For some time this town has been receiving considerable attention from various parties interested, who are studying its resources and adaptability to beet-sugar production.

There is in process of erection, to accommodate the water supply of this place, a reservoir holding 1,200,000,000 cubic feet of water. When this is completed, the place will possess all the requisites for facilitating the wants of a sugar factory. During the past summer parties interested made a proposition to build a sugar factory at this place, to be in operation in 1905, provided the farmers of the community would contract to grow sufficient beets to maintain it. Conditions in this locality for growing sugar beets have been pretty thoroughly tested. Beets have been grown for factories in the western part of the State.

In 1903, 700 tons of beets were produced in this vicinity. Of these 550 tons were shipped to Eaton, Colo., and 150 tons to Grand Island, Nebr. The best field of beets of 3 acres or over produced an average of 12 tons per acre, and tested in sugar content 18.2 per cent. The estimate of cost of producing these beets was $30 per acre. It seems probable that a factory will be erected in the near future.

Mr. Mark Burke of this place has taken an active interest in locating a sugar factory at this place, growing sugar beets, and encouraging the industry. In response to my inquiry he makes the following report touching the results of beet growing, prospects for a factory, and the general development of the facilities incident thereto:

JULESBURG, COLO.

DEAR SIR: We have only been experimenting two years, and on a very small scale, but results were so satisfactory that farmers are almost unanimous in declaring sugar beets the most profitable crop at present price ($5 per ton f. o. b. Julesburg); but we understand the price is to be cut 50 cents per ton, and, if that is the case, no more beets will be raised here until we get a factory. Our beets yielded from 8 to 18 tons per acre, and when we sold by the "sliding scale," i. e., $4 per ton for beets testing 14 per cent and 25 cents per ton for each 1 per cent above that, they averaged 18.2 per cent. We have 40,000 acres of good beet land tributary to this town, and are now building a large storage reservoir, with a capacity of 1,200,000,000 cubic feet, at a cost of $390,000.

Respectfully, yours, MARK BURKE.

LAMAR.—This town is situated in Prowers County, on the Arkansas River, in the eastern part of the State, one county removed west of the Kansas line. For several years beets have been grown extensively in this locality for the factory at Rockyford, the property of the American Beet Sugar Company. Beet growing for this factory has also been carried on extensively in Kansas, east of Lamar, on the Arkansas River. Both of these districts produce high-grade beets. In comparison with other things the crop has also proven very remunerative to the farmers. The factory at Rockyford has now established a permanent supply nearer home. The company recently decided to construct a plant at Lamar. This Lamar plant will be about 100 miles east of Rockyford. It will probably absorb the supply of beets grown in Kansas, which will bring the Kansas district 100 miles nearer the factory buying its beets.

The machinery for the factory at Lamar is to be removed from Norfolk, Nebr., where it has been in operation for the past fourteen years. It is the plan of the company to improve and enlarge it when installed at Lamar. In conformity with the regular plan of this company, it has purchased a large tract of land in the vicinity, which this sugar factory will develop agriculturally. Foundations and buildings are now being constructed at Lamar, and the dismantling and forwarding of the machinery is proceeding at Norfolk. The factory will be in active operation in 1905.

When the agricultural district at Lamar has fully developed, so as to produce beets to the capacity of the factory, a sufficient start will have been made on the Arkansas River in Kansas to build a factory at some desirable place there.

STERLING.—For some years Sterling has been practically demonstrating conditions favorable to a beet-sugar factory by growing beets more or less commercially for other factories.

In 1903, 2,300 acres of beets were raised in Logan County, in the vicinity of Sterling. All of these were irrigated by water from the South Platte River. The beets were grown under contract for the factory at Eaton, Colo., and averaged 16 per cent sugar; many of them as high as 18 per cent. The average tonnage was about 8 tons per acre; one 15-acre field yielded 20 tons to the acre. The average cost of production per acre is $37.50. Another 10-acre tract yielded 15 tons per acre. This was on bottom lands, and the cost of production was $35 per acre. One 80-acre tract planted to beets by the Sterling Beet Growers' Association averaged 10 tons per acre. It had never been cultivated before. It had been in alfalfa, sown on the sod, the stubble of which was broken by a steam plow. The cost of production of beets on this ground was $45 per acre.

Many of our present factories would be pleased to receive the beets from 2,300 acres, the acreage grown in this vicinity without the stimulus of a sugar factory. This is a very good showing for a farming community new in the business. It carries with it considerable assurance to those establishing a sugar factory to operate in this place in the future.

Sterling is situated in Logan County, on the South Platte River, at the junction of the Denver and Rio Grande and the Union Pacific. Its availability in sugar production has been under consideration by many different parties for the last two years. Several times the establishment of a factory seemed assured.

In order to obtain the latest and most definite information touching beet growing for 1904 and arrangements for installing a sugar factory, I sent a letter of inquiry to Mr. C. B. Goddard, president of the Beet Growers' Association of this place, who forwarded the following report:

STERLING, COLO., *December 24, 1904.*

DEAR SIR: Your communication regarding sugar beets at hand. While our country has passed the stage of experiments, I will gladly give you our report.

We grow beets entirely under irrigation; we raised in 1904 1,000 acres. They averaged 13 tons per acre with an average of 16 per cent of sugar. The beets at $5 per ton made $65 per acre, an average profit of $30 per acre.

We now have contracted for the 1905, 1906, and 1907 crops 4,000 acres of beets, and have a contract for the construction of a sugar factory to begin building May 1, 1905, the factory to be built by the Havemeyer interests.

Our irrigated lands are among the best in Colorado, and eastern farmers are moving into our country very rapidly. The South Platte Valley will grow about 8,000 acres of beets for the 1905 crop.

Any further information will be cheerfully given.

During 1903 a delegation (about forty in number) of German agricultural experts visited this country, consisting of the most scientific representatives of that Empire. It made an extensive tour and a study of our agricultural resources and conditions. The members were especially attracted to our sugar districts. Some of them have revisited this country seeking lines of investment appealing to them on their former trip. This inspired other German investors to investigate in conjunction with some of this original delegation. For beet growing that part of Colorado covered by the Platte attracted considerable attention. These gentlemen had in view the establishment of several sugar plants along its course from Denver to the eastern boundary of the State. Sterling itself received the special attention of these foreigners.

The company of Colorado capitalists controlling the six large sugar factories in the north part of the State, headed by C. S. Morey and Charles Boettcher, of Denver, finally organized the Sterling Sugar Company, which will build a factory at this place, to be in operation for 1905. By the articles of incorporation the company is to operate in Logan, Sedgwick, Phillips, Washington, Weld, and Adams counties, and the city and county of Denver. It will be thus seen that these include most of the territory tributary to the South Platte. The company is capitalized for $1,500,000, and probably contemplates building sugar factories at all the points that have been under investigation the same as Sterling, such as Julesburg, Brush, Fort Morgan, and other places mentioned in these reports from time to time. The conditions around Sterling have been tested; beets have been grown quite extensively for the factory at Greeley and for other factories in that vicinity.

HOLLY.—It has been definitely settled that a beet-sugar factory of 600 tons daily capacity is to be erected at Holly, Colo. This factory will be constructed and equipped during the present summer. The beets for its first campaign will be grown during this season, and it is to be in operation this fall. The Arkansas Valley Sugar Beet and

Irrigated Land Company is building the factory. Its inception is largely due to the efforts of the manager of the company, Mr. W. H. Wiley.

IDAHO.

For several years the State of Idaho has been under careful investigation. Conditions favorable to the beet-sugar industry at many places have been clearly demonstrated. As in the other Mountain States irrigation is necessary; but the irrigation facilities, in comparison with the crop possibilities of the State, are slightly developed. As a rule the irrigation ditch must precede the sugar factory. The business energy of the State has been exerted in securing capital for developing its mines. To secure capital to the extent of installing a sugar factory and irrigation systems was a difficult problem.

While there is water in abundance coursing through the running streams of Idaho, its utilization presents difficult engineering problems. For instance, the Snake River crosses the southern part of the State from east to west, and continues north forming nearly half of its western boundary. Throughout its length peculiar shore formations occur. These are mostly of solid rock, high and steep. The valleys are more or less removed from the stream, sometimes cut off by hills and mountains. The problem has been to get this water out over these high rocky shores and into the valleys. Many projects contemplate tunneling under mountains to secure water for irrigation. Many beautiful valleys and stretches of land in the State remain unwatered and unimproved on account of this situation.

The State possesses in a high degree those peculiar conditions of soil, atmosphere, and sunshine so necessary to the production of beets of high quality. Sugar beets, like other root crops, thrive best when the sun is not too hot and wilting, and yet the sun is one of the strongest factors or reagents in elaborating the sugar in the beets. In this State we have many cloudless days of gentle, even temperature, especially helpful in growing and ripening the crop. The peculiarities of this climate are not favorable to sugar beets alone, but also to fruits. Apples are of large proportions, excellent quality and color, and fine texture.

The State has been a little slow in the development of her agricultural and horticultural resources, purely from lack of capital. Such capital as has previously reached the State has been diverted into her mining enterprises.

During the last two years three sugar factories were installed—at Sugar City, Idaho Falls, and Blackfoot, all on the Snake River. The accomplishments of these factory districts are advertising to the world the vast agricultural resources of the State. The sugar factory, when once introduced, is a concern of sufficient influence to attract

capital. It installs machinery, buys large tracts of land, builds irrigation ditches and reservoirs and local transportation lines, both steam and electric.

It is not possible to devote to sugar beets all the arable territory brought under cultivation. To install an irrigation ditch having an abundant supply of water means the reclamation of a large body of land. To employ this land to the limit of its availability leads to the growing of all other crops indigenous to the section. With the establishment of the factory and the ditch, the fruit, grain, potato, and stock grower, the creamery producer, and every other person of whatever intensive farming interest, finds the fulfillment of his long pent-up designs and schemes for utilizing the fertile valleys of Idaho.

Here we see repeated the remarkable experience of Colorado, except that that State had already watered large areas of land and started diversified agricultural production to a considerable extent. The sugar industry in that State simply intensified all these. In the State of Idaho the beet-sugar industry has been introduced in association with the other industries. All thrive better under the stimulus of the factory.

Idaho has also some of the conditions which favored the industry in Utah. It is estimated that at least one-third of the farmers of Idaho are Mormons. In previous reports I have reviewed the special training of these people, accustomed to the closest kind of intensive production on small plats of land, making the most out of little. The system and oversight pervading the operations of this sect, as shown in the wonderful accomplishments of Utah, augur much in their application in developing the agricultural resources of Idaho. They are especially favorable to the beet-sugar industry and adaptable to the desert and its reclamation through irrigation and intense cultivation.

CALDWELL.—For some time there has been careful study given to what is known as Boise Valley, in the western part of the State. This valley is tributary to Snake River and is the seat of the capital of the State. It is supplied with better transportation facilities than any other portion of the State. In it are located several live towns, among which are Caldwell, Boise, and Nampa.

Experiments in growing beets have been conducted from year to year through various agencies. These have always resulted in the production of good beets of high sugar and purity in the valley. It probably has more natural factory facilities than any other part of the State. From several sources negotiations have proceeded with local business interests with a view to establishing a factory at one of these places. There has been considerable rivalry among these towns as to which would secure the site. During the fall of 1904 it was quite reliably announced that an organization had been effected and a factory would be built at Caldwell. It appears that this will be an outgrowth of the

sugar industry in Utah. Parties operating factories in that State are behind the proposition. It is quite evident that a factory will be located at one of these places in the near future. The location at Caldwell seems almost assured.

IOWA.

In Iowa the sugar industry experienced a lively revival of interest during the past year. To at least four places propositions to install factories were made by those interested in beet-sugar production. Throughout the past ten years different places in this State have been under investigation by many parties interested in the subject. During that period its resources have been thoroughly tested experimentally. The experiment station at Ames took a leading part. In almost every county beets have been grown and tested in its laboratories.

Through these experiments and its well-known agricultural and natural advantages it has always ranked among the leading States in this respect. For this industry the northern half of the State has been considered most available. This portion of the State seems best adapted to the industry, but the soil is generally fertile, and beet growing and field crops generally are profitable in all parts of the State. As a rule, sufficient rain falls for all crops. With beets, as with other crops, assurance of a crop year after year is the greatest requisite.

The State has developed large agricultural interests. It is probably the best balanced, agriculturally, of any State in the Union. As a rule, farmers are progressive, successful, and satisfied. In fact, this has been the main obstacle to installing the sugar industry there. The farmers have not shown a disposition to grow the beets. When the farmers are advised that beet culture is accompanied with considerable hard work, factory propositions usually succumb to the inevitable. The farming class of the State is accustomed to the use of labor-saving implements in the fields. The drift of methods has been away from hand work rather than to it. However, it may be said that Iowa possesses in a strong degree all the requisites for maintaining the industry when once it is installed. She has the quality of soil and climatic conditions necessary for producing a large tonnage of beets. Experiments throughout the State have indicated that the beets are satisfactory in sugar content and purity.

There are many railroads penetrating the State in every direction, many trolley lines cutting across the farming districts, and many new ones projected. While there are but few large cities there are many prosperous, active smaller ones.

Throughout the central part of the State, from north to south, coal is found in abundance. It would be almost impossible to locate a factory in Iowa not convenient to a coal supply.

The general live-stock interests of the State are greater than those of any other in the Union. Especially extensive are those of feeding and breeding. The creamery and dairy production of the State approximate an annual value of $40,000,000. In the State are already developed to a remarkable degree all the facilities and resources needed by the beet-sugar industry, as well as the other industries which would benefit by its establishment. To the industry itself these would contribute at once those influences most conducive to its highest success. To a considerable extent beets have been grown in several places for factories in other States near her borders. To the factories receiving them they have always been satisfactory.

For climatic reasons the beets grown in Iowa have not been as high in quality as those grown in California, Colorado, or Idaho. However, they are of a quality entirely satisfactory, and they can be produced at a cost lower by 25 per cent. The strong point of Iowa beets is the surety of the crop. Beets of high quality are very desirable; so is a good yield. Beets may be high in quality and at the same time the yield may be light and not remunerative to the grower. A factory desires, more than anything else, a permanent, constant supply of average beets. A factory can better afford to work on a full supply of average quality beets than on a half supply of high-grade beets. Given sufficient tonnage to pay the cost of production and a fair profit and we have encouragement for the farmer. As in any other business, profit in farming is the one thing that stimulates the production of any particular crop. The management of every factory fully appreciates that the profits of the beet growers are the guaranties of the factory's continuance.

In connection with this industry the Iowa farmer has failed to fully understand a few things. In considering it he has riveted his attention on the laborious work of growing the crop. Some day he will discover that the beet crop will enable him to employ and pay labor, and will yield a good profit besides, and that he need not work harder than in producing other crops. He will discover that it improves his land, both mechanically and in fertility; that he can sustain more live stock, and that he can sell or rent his land for more than he otherwise could.

The places under consideration during the past year were Des Moines, Clinton, Waterloo, and Davenport. Parties owning two factories in Michigan, owing to an oversupply of factories and a consequent scarcity of the beets there, proposed moving them to new places. Negotiations were opened in Iowa with a view to establishing these plants at some of the places named.

DES MOINES.—Around Des Moines beets have been grown experimentally for several seasons. It has been established beyond a doubt that good beets can be produced in the locality. The city is quite a

manufacturing center, and to a considerable extent is a local distributor of sugar to other points. The subject of establishing a beet-sugar factory has been before the business interests of the city many times. On several occasions it seemed sure that a plant would be established here, but for various reasons these considerations have failed of final fruition. The commercial exchange took considerable interest in this proposition from Michigan, several meetings were held, but nothing was accomplished.

CLINTON AND WATERLOO.—The proposition followed practically the same course in Clinton and Waterloo. From an agricultural standpoint Waterloo is one of the best locations in the State. Here the farming district has a quality of soil especially adapted to sugar-beet culture. The consideration of this question has been up so many times before the business men of these various places, and interest has waned, that it seems impossible to crystallize anything tangible in the present instance.

The proposition made at these places was this: The plant, including all machinery and metal structure, was to be appraised at a fair value by engineers and representatives of both interests. For this the Michigan company proposed to take stock. A new company was to be organized in Iowa to subscribe the rest of the stock and to procure the money to move, install, and operate the plant. Waterloo exhibited more active interest generally than did either Clinton or Des Moines. It seems the proposition failed for the present from inability to raise the money required.

DAVENPORT.—In Davenport the proposition met with a much more hearty support. The commercial club of that city took it under active consideration; a committee was appointed to go to Michigan, examine one of the plants, and negotiate with the owners for its removal. Several meetings were held by the business men of the city; finally sufficient capital was raised and the company was organized; committees were appointed to secure contracts with the farmers, with the result that Iowa secures a beet-sugar plant to be installed in Davenport for the campaign of 1905.

For the introduction of this industry into Iowa it was probably fortunate that Davenport should be the place selected. The city has many seperior advantages. (1) It has abundance of capital to carry forward an enterprise of this kind; (2) it has river transportation for bringing in crude materials and shipping out the finished product; (3) its business men are energetic, successful, and progressive; (4) from it radiate railroads connecting with others penetrating every part of the States of Iowa, Illinois, and Missouri; (5) it is a wholesale distributing point of considerable pretense; (6) it has cheap fuel; (7) in its vicinity are large dairies and creameries; (8) the industry is admirably adapted to its community, which is largely of the German extrac-

tion, accustomed to intensive farming on small plats and gardening in general; (9) it is one of the largest manufacturing points in the State of Iowa, and its industrial concerns are generally successful. It is sure to succeed in the beet-sugar industry.

In the Iowa Daily Capital, January 3, appeared the following terse description of this plant and its organization:

The articles of incorporation of the Davenport Sugar Company were signed Saturday by Melzar J. Eagal, Bruce T. Seaman, Albert L. Mossman, Martin H. Mueller, John B. Phillips, Ambrose P. McGuirk, and Adolph H. Stoltenberg. Melzar J. Eagal was elected president, and M. H. Mueller secretary. The capital stock of the company is $600,000, and it is expected to put into circulation from $750,000 to $1,000,000 during the coming year.

It will be necessary to begin the construction of this enormous plant not later than April 1, 1905. The main building will be 400 feet long by 80 feet wide and 5 stories high, being wholly of steel, cement, and brick, absolutely fireproof. The boiler-room will be 250 feet long, 75 feet wide, and 4 stories high; the lime house 200 feet long, 75 feet wide, and 4 stories high. The machine shop will be 60 feet by 50 feet. The beet-storage house will be 400 feet long and 150 feet wide. The sugar store and ware house will be 200 feet long by 75 feet wide, and 2 stories high. The office will be a two-story building, 40 by 60 feet. It will require from April 1 to October 15, 1905, for between 350 and 400 mechanics and laborers to construct the buildings and install the machinery. To supply this plant it will require 5,000 acres of sugar beets, which it is expected will produce 25,000,000 pounds of sugar annually. To operate the plant will require 350 men. The pay roll per month will be approximately $21,000. The factory will consume 100 tons of coal per day.

IOWA CITY.—During December, 1904, Iowa City took up the matter of installing a sugar factory. The same Michigan parties who conferred with the business interests of Waterloo, Clinton, Des Moines, and Davenport, tendered the Commercial Club of Iowa City the same proposition to move a plant to that point.

President Coast and Secretary Devorsky, of the club, have been authorized to confer with the sugar company on the subject. Business interests generally are actively considering the subject and investigating the possibilities of securing sufficient beets in the immediate vicinity.

MARSHALLTOWN.—For years a glucose plant has been in operation at this place. Recently the management of the concern has been giving special investigation to its farming territory, with a view to changing from a glucose to a beet-sugar factory. Considerable interest is taken in this enterprise by the business men and farmers in its vicinity. There are strong probabilities that this change will occur, and in the near future a beet-sugar factory will be in operation.

ILLINOIS.

Through the State Experiment Station at Champaign, this State has been tested exhaustively for conditions favorable to the beet-sugar industry. Its commercial facilities are strategic. It has a network of

railroads connecting its commercial centers and ramifying through its agricultural districts in every direction.

It is bounded on the west by the Mississippi River, affording water transportation on its western border for crude material and finished products. Its soil, which is adapted to field crops of all kinds, has shown favorable results generally for growing sugar beets. The northern half of the State is considered quite favorably adapted to the sugar industry. Its proximity to the great distributing market of Chicago, both by rail and lake, are especially favorable. Gardening, dairying, stock production of all kinds, and every kind of intensive agriculture adapted to the section is highly developed.

It has all the natural and commercial facilities necessary for successful beet-sugar production. It has probably considered, at different times, as many projects for the establishment of factories as any other State in the Union. Up to date none of these have been consummated, except that in 1899 a factory of 500 tons capacity was built at Pekin. This place is in the western part of Taswell County, on the Illinois River, near Peoria. The season was quite abnormal for all crops. This, with the other difficulties of a first year's experience of the farmers in growing beets, resulted in poor beet crops. The district is especially interested in whisky and glucose production. After the first years' experience the farmers showed a disinclination to beet growing, and the factory was dismantled and the building used for one of these other industries.

The projects that have received attention for the last three years and seem most probable of consummation are these contemplated near the city of Chicago itself. For some time particular interests in Chicago, especially wholesale grocers, have been considering the erection of a plant somewhere in the suburbs of the city. Several of these proposed factories have seemed at times practically assured; but for one reason or another they have finally been abandoned.

RIVERDALE.—During the present year a distilling property at Riverdale was utilized by Mr. Charles Pope, of Chicago, for establishing a beet-sugar factory. This location is near the suburbs of the city. The buildings have been constructed and are now being fitted with machinery; contracts are being made with the farmers, and the plant will be in operation here in 1905. This project is under the control of Mr. Charles Pope, of Chicago. In order to get information as to the exact status of this enterprise, I wrote Mr. Pope and received from him the following reply:

CHICAGO, *January 12, 1905.*

DEAR SIR: In reply to yours of January 7, would say I am building a beet-sugar factory at Riverdale, Cook County, Ill., 17 miles south of Chicago, on the Illinois Central Railroad.

I have the buildings completed, all the machinery bought, and part of it installed.

It is on the property formerly occupied by a distillery, which was burned down some years ago.

I have commenced taking contracts for beets, but am not getting them as fast as I should like to; am afraid there will be difficulty in getting enough to run with. The capacity of the factory will be 350 tons per day.

Yours, very truly, CHAS. POPE.

MICHIGAN.

Michigan has installed more factories than any other State in the Union. The first was established at Bay City for the campaign of 1898. Since that time 20 others have been built and operated; two others at Charlevoix and Mount Pleasant have been under construction a couple of years. These two concerns contracted beets for 1903 and 1904, but owing to difficulties which prevented the completion of the plants the beets have been disposed of to other factories.

In Michigan we find most of the unfortunate records chargeable to the beet-sugar industry since its inception. These were results of natural and economic causes. There was too much rush and not enough careful study of economic conditions in establishing the factories. Factory building was pushed beyond its resources. Too many plants were located in too small an area; few of them received enough beets on that account. If sufficient time had elapsed for developing the resources, Michigan could have sustained all the factories she had built. As it was, some of them led a precarious existence. Two of them have been removed from the State, the one at Benton Harbor to Canada, and the one at Kalamazoo to Chippewa Falls, Wis. Possibly two or three more may find it necessary to seek new locations.

In development the energies of the State had been largely directed to other lines than agriculture. There are few States sufficiently fortified, agriculturally, to undertake Michigan's task in the sugar industry. None could have constructed and carried to successful operation 23 factories in the short time during which it was attempted in that State. In installing so many factories under the high pressure of agitation, the business interests of the State were moving too fast.

The State has many natural advantages. Through these, and a higher development of conditions in the farming sections around these factories, most of them will eventually pull through. To sustain 23 factories large live-stock interests are needed—feeding, breeding, and dairying—also extensive diversified cropping in general and a farming class accustomed to rotation, fertilization, and intensive culture of crops. These are things of natural growth requiring long experience. They come through gradual agricultural development; they are not built up in a night, a week, a month, or a year. They come in the natural evolution of things, through a decade or a lifetime. They may be stimulated by a "shaking up," such as the sugar indus-

try has given Michigan, through losses and consequent reverses, but even then considerable time is necessary.

You can not make a first-class farmer out of a poor one unless he is young or new in the business. As a class, in Michigan, good farmers are not the rule. You can not project the best agricultural sentiment or practice in a moment. Farming in the State at the introduction of the sugar industry was not so prominent as an industry as it was in many other States. As with mining in Colorado, this State was devoted to lumber production. This was the fixed industry, the one receiving the devoted energies and attention of the press and the united support of public sentiment. That it was waning and its end fast approaching, all felt assured. Naturally something else must be introduced to utilize the energies and capital of the people of Michigan.

Under such conditions the sugar industry appeared on the scene. The business men of the State were already organized in companies and found their business declining. The hum of the sawmills was gradually growing faint. Those still in operation were running on short supplies. The sugar industry was greeted as a great benefactor. Unfortunately its requirements were greatly underestimated.

Sugar companies were organized on short order, sites selected, and contracts arranged for growing beets and building and equipping plants. Regardless of conditions, economic or otherwise, the sugar factory was greeted as the Moses, the deliverer, of the business community of Michigan. In some places factories were located too close together. Had their resources been well developed these districts could not have furnished beets sufficient to supply these factories to their full capacity during all seasons. Michigan has favorable resources when they shall have been fully developed.

The results of all this haste and enthusiasm was confusion, jealousy, and strife. Neither factory men nor farmers had had sufficient experience to guide them through the difficulties. The results were that two factories stopped building when nearly completed, two others have removed, and two or three more will probably do so.

Many of these companies paid from $5 to $6 per ton for beets, extracted the sugar, threw the pulp away, and lost one-third of the investment in this transaction. Excessive rains and unusual droughts, occurring in this pioneer experience, added to the difficulties. Yet the history of the misfortunes developed by the sugar industry in Michigan justifies no conclusion except that there were some mistakes underlying all the work done. There is much favoring the industry in the State. Any verdict of public opinion or press, intimating failure of the industry in Michigan, is premature. We can not have a fair judgment of the sugar industry in Michigan until all the facilities have been developed, and the soil and climatic conditions have been thoroughly

tested. It can be said that the situation is improving. Conditions are becoming better understood. Even the unfortunate circumstances attending its development will, in the end, be to the advantage of the industry.

Naturally there are not many new factories under consideration at the present time. The energies of the State should be devoted to the completion and operation of those factories already installed. Whatever new projects are now considered are simply the outgrowth of naturally strong causes developed by the factories operating in the State in the past.

Michigan has many advantages for the beet-sugar industry. It has lake transportation. The great market centers—Chicago, Detroit, and Buffalo—are easily accessible. The factories get the lowest freight rates on crude materials and finished products. The day will come when all these advantages will operate to develop the sugar industry in the State.

Among the places receiving attention during the past season the fol lowing may be named:

SAULT STE. MARIE.—At this place beets have been grown experimentally for the existing factories. On account of its location, as the gateway of a great commercial highway, it has received considerable attention. During the past season it has been especially under investigation. It appears that two or three different organizations are ready to construct a factory at this place whenever beet production shall have developed to such an extent as to insure a sufficient supply of beets.

As indicating the purpose of parties locally interested, and those considering this district for the installation of a sugar factory, I clip from the American Sugar Industry and Beet Sugar Gazette, Chicago, Ill., November 5, 1904, the following:

> The Michigan Investor in its last issue says: "Judge Wm. M. Snell, of Sault Ste. Marie, has received an analyses of sugar beets grown in Chippewa County, recently sent to the Sanilac Sugar Refining Company, which is of a flattering nature. The letter was written by Manager G. G. Scranton, and praises the beets highly. The beets averaged 14.3 per cent sugar, and in purity 86.1. Mr. Scranton says they are worth $5.27 per ton."
>
> Judge Snell has been one of the most energetic workers in behalf of the establishment of a beet-sugar factory at "the Soo," and as a result of the experiments this year he is greatly encouraged.

In order to get the latest developments, I communicated with Judge Snell, and received from him, under date of January 2, 1905, the following report:

SAULT STE. MARIE, *January 2, 1905.*

DEAR SIR: Replying to your valued favor of the 23d ultimo, I would say that it is impossible for me to give you a detailed statement of the results of the experimentation that has been made here in the matter of sugar-beet culture. Most of these experi-

ments have been made in a desultory way, without reference to amount of acreage, tonnage, etc. Some years ago, believing that the climate and soil here were well adapted to the growth of the sugar beet, I ordered a supply of seed and offered prizes to be awarded at the county fairs for the best exhibit of beets. This I have continued to do each year since to keep the matter before the minds of the farmers. Three years ago I found parties who were willing to erect a factory here provided the necessary amount of acreage could be subscribed. Acting with the chamber of commerce in this city, I took the matter up, and we made an active effort to awaken interest and secure the factory. The result of the experiments at that time was turned over to the secretary of the chamber, and, as that organization has become defunct and the then secretary gone to other fields, I am unable to secure for you the figures. I can state from recollection, however, that the analysis showed a sugar content running from 12 to as high as 19 and 20 per cent; quite a number ran as high as 18 per cent. The purity I do not recollect. The tonnage, as near as we could get at it (only small amounts being grown), ran from 10 to as high in one instance as 22 tons per acre.

This year quite a number of our farmers made contracts to grow beets for the Menominee factory, which, though situated a long distance from here, took the beets, the railroads making special concessions on rates for the purpose of demonstrating what could be done. A late and wet spring prevented planting until late, and I do not think the results have been satisfactory, although I have not heard the actual results from the factory.

This year I only sent one lot out for analysis. These were in good shape and the returns from the factory showed a sugar content of 14.3 per cent of sugar, and a purity of 86.1, which was a satisfactory showing. The prospects for a factory are not very bright at present, as I was able to secure less than 1,000 acres when we made the canvass two years ago, and since that time the interest has waned, although I have endeavored to keep the matter constantly before the public.

Yours, respectfully, WM. M. SNELL.

BLISSFIELD.—Michigan is to have another factory of 600 tons daily capacity. It is to be erected by the Lenawee Sugar Company at Blissfield. The contract for the building and equipment of the plant has been let to responsible parties, and it will be installed during the present summer. The Company has secured contracts with the farmers for 6,000 acres of beets, 3,000 acres of which, it is claimed, will be within wagon-hauling distance of the factory; the rest of the acreage is not far distant.

The officers of the new company are: David Brown, president; John Iffland, vice-president; W. H. Burns, secretary; C. R. Phillips, treasurer; and R. S. Woodrow, managing director.

MONTANA.

For some years in various parts of Montana there has been considerable agitation touching beet-sugar production. Experiments have been conducted on an extensive scale in many parts of the State. These have indicated that Montana, so far as soil and climate are concerned, has conditions quite similar to the other Mountain States, such as Wyoming, Colorado, and Idaho.

To grow sugar beets in this State irrigation is necessary. It is watered by the two branch systems of the Missouri River, one in the northern and one in the southern part, each flowing east. The great Missouri River has its origin in this State. It has as a part of the system the Yellowstone, which rises in the southwestern part and flows diagonally toward the northeast. Most of the districts in the State under investigation for sugar-beet production are located tributary to the rivers which afford irrigation facilities.

Following these watercourses there are three principal railroad systems: (1) The Great Northern in the north and (2) the Northern Pacific and (3) the Burlington and Missouri River Railroad in the south. The Great Northern and the Northern Pacific extend on through the State of Washington to the coast on the west, and eastward to the shipping centers of the lake region. Both of these routes have splendid facilities for through shipping from coast to coast.

Agriculturally Montana's resources are new and developing. Not nearly all the water in the State is utilized. At present irrigation is largely conducted from running streams. Each season there is a vast quantity of water running to waste to the sea. Many storage systems are in contemplation. When these are consummated, the agricultural resources of the State will be very much increased. At present it is a great grazing State, as the production of alfalfa and other forage crops is increasing, while dairying, creameries, and feeding are coming more into vogue.

There are many things favorable to the industry in general. Beets grown in the State are of high quality. Wherever sufficient water is obtained they are very productive. There are five or six places actively considering the installation of beet-sugar factories. I will mention those receiving the most attention this season.

CONRAD.—For four or five years different parties have been actively investigating this district. It is in Teton County, in the northern part of the State, bordering on the Canadian line, and one county removed from Idaho. The town is situated near the Great Northern, on the Great Falls and Canada Railroad. The farming district is watered by the Marias River, a tributary of the Missouri.

Experimental tests of the beets grown here have always indicated high quality. Parties representing the combination owning the six northern factories of Colorado, of which the American Sugar Refining Company is the principal, have been negotiating with the business interests of Conrad with a view to establishing a factory. An expert representing these interests thoroughly investigated the Conrad district during the summer. It is generally understood that he represents the American Sugar Refining Company and usually advances its projects for establishing new factories. It was given out by those

locally interested that a factory would be established here, provided sufficient acreage could be secured for growing the beets.

In regard to growing sugar beets in the district, I wrote the Conrad Investment Company and received the following report from M. S. Darling, their engineer:

CONRAD, MONT., *December 27, 1904.*

DEAR SIR: In reply to your communication touching the trials that have been made in raising sugar beets, I would state that so far there has not been any special effort made in the raising of the beets. A number of parties put in a few this spring to see what could be done, but never took any particular care of them. However, they have been able to produce beets weighing from 2 to 6 pounds, with percentages of sugar from 14 to 16, and I understand one party last year raised some that went as high as 19 per cent.

There are a number of parties in this section that are intending to put in beets again in the spring and will give them a better trial. This company raised some this year, but so far no tests have been made of them.

Respectfully, yours,

CONRAD INVESTMENT CO.,
By M. S. DARLING, *Engineer.*

BILLINGS.—Another place receiving considerable attention in the State is Billings, situated in Yellowstone County. The county is crossed from the southwest to the northeast by the Yellowstone River. Billings is centrally situated on the river; also on the Northern Pacific Railroad. Irrigation is conducted from the Yellowstone. During the past season considerable activity was manifested in this district in investigating conditions and negotiating with capitalists with a view to establishing a sugar factory.

The Billings Land and Irrigation Company has constructed a ditch, tapping the Yellowstone and supplying water to 10,000 acres of land. This was largely the stimulating cause of the negotiations for a sugar factory.

December 2 a meeting was held, largely attended by farmers and local business men. It was addressed by Col. H. W. Rowley, M. A. Arnold, Henry White, W. B. George, H. M. Allen, E. B. Kent, W. H. Donovan, W. O. Parker, and I. D. O'Donnell. These represented those pushing the project locally. Previously a fund of $10,000 had been subscribed to carry on the preliminary work of investigation, etc. Assurance was given by the above gentlemen that sufficient acreage could be procured providing a factory is installed. F. M. Shaw, promoter of the enterprise, and Mr. Hawley, an expert from the Colorado districts, also participated. Half of the acreage required was guaranteed at this meeting. As indicating the interest in the enterprise, I reproduce here a report made by the committee previously appointed to visit the beet fields and sugar factories of northern Colorado. This committee was composed of W. O. Parker, C. M. Chaffee, Christian Yegen, L. A. Nutting, M. A. Arnold, W. H. Donovan, I. D. O'Donnell, and W. T. Clark. The report in part is as follows:

We have talked with men in the offices of the sugar factories, with men who olicited contracts with the farmers for beets, with men who have worked by the nonth on farms, with men who have farms for sale, with men who have farms for ent, with men who live on farms and grow beets, with professional men, business nen, and retired men, and they all, without exception, speak of the beet industry in he most glowing terms and with the most unbounded confidence as being profitable or the farmer, whether he be an owner or a renter, and increasing the value of land rom 5 to 150 per cent.

We will say that it is our opinion that lands tributary to Billings have all the dvantages for the growing of sugar beets that the Colorado lands have, and some vhich they do not possess, namely, the absence of the hard, freezing weather in May which northern Colorado is subject to. Another very decided advantage is hat we have a plentiful supply of water for irrigating the crop, which, we are nformed, is very essential in growing sugar beets.

Now, we desire to impress on the farmers that it is absolutely necessary, if we are o reap the great advantages to be derived from the establishment of a beet-sugar actory, that they must assist in making contracts for the raising of the beets, because until a sufficient acreage is absolutely assured no company will consider the natter of establishing a factory here. We therefore, as a committee, urge and recommend that all farmers who are in reach of the factory or railroad enter into contracts at once for all the acreage they can respectively handle, so that the matter can be taken up in time by the factory people and the factory be built and placed in readiness to take care of next season's crop. Unless this is done we can not hope to secure the factory.

With reference to this project I publish an article appearing in the In-Mountain, of Butte, Mont., December 7.

The building of a beet-sugar factory in Billings and the planting of a large acreage of beets next season are assured. A stock company has been formed whose purpose is to buy or lease 1,000 acres of land in the Yellowstone Valley to raise sugar beets, and more than half the stock has already been taken. It is expected that the factory for the treatment of the beets will be in readiness for operation next fall. The soil of the Yellowstone is said by experts to be admirably adapted to the culture of sugar beets.

With reference to the conditions around Billings, the experimental work done, and general interest in the beet-sugar industry, I received from Mr. Henry White, secretary of the Billings Club, the following report:

BILLINGS, MONT., *January 13, 1905.*

DEAR SIR: Replying to your favor of the 17th of December, 1904, I beg to say that sugar beets have been grown in the Yellowstone and Clarks Fork valleys, in eastern Montana, in an experimental way and on a small scale for feeding for a number of years.

The results obtained in this manner, while little more than an index of what might be done under systematic cultivation and with a knowledge of how to attain the best results, have been so satisfactory, both as to tonnage and sugar content, as to attract the attention of capital interested in promoting the beet-sugar industry.

The mean temperature of the Yellowstone Valley for the summer months is about 71° F., with freedom from frosts from early May to early October. Its elevation is about 3,000 feet above sea level, with a soil varying from deep sandy loam to heavy clay, some alkali being present in all the heavier soils. Good limestone, coke, and steaming coal are all found within a radius of 100 miles at prices which compare

favorably with those being paid in other localities where beet-sugar factories are now successfully operated.

We have but one record prior to 1898, namely, that of C. L. Tilden, of Park City, who had three tests made at the Bozeman Agricultural College (Lab. No. 239), showing 15, 16, and 17 per cent sugar, respectively. In 1898 I. D. O'Donnell and Charles I. Gardner, both of Billings, submitted beets for analysis, running from 7.98 to 10.92 per cent sugar. In 1901 three Yellowstone Valley growers submitted beets ranging from 12.36 to 17.2 per cent sugar, while thirty-two samples were sent in from the Clarks Fork Valley showing a sugar content ranging from 12.73 to 21.56, with a general average for all of 16.97 per cent.

The tonnage attained throughout these experiments ranged from 6.5 tons to the acre to 25 tons, only five falling below 15 tons per acre.

The purity coefficient varied from 41 to 90, with an average of 80.5.

For 1902 only four samples were sent to Bozeman for analysis. These showed 17.95 per cent sugar and 81.3 purity; 17.1 per cent sugar and 78.6 purity; 14.9 per cent sugar and 85.3 purity; and 17.86 per cent of sugar and 89.1 purity, respectively.

The foregoing is practically all the information bearing on the question of sugar-beet culture now in the possession of the committee.

Yours, truly, HENRY WHITE, *Secretary.*

The Times, of Billings, December 12, gives the following information showing that all arrangements have been made for installing a sugar factory at this place, to be in operation for 1905:

All the land required, 6,000 acres, was subscribed at Saturday afternoon's business men's meeting at the city hall, many farmers also being present. So the beet-sugar factory is a go for Billings, and Mr. F. M. Shaw, the promoter and expert, will leave for the East this week to order the necessary machinery for the plant. Several hundred acres more ground than was needed was tendered by ranchers living south of the Yellowstone River. This offer will be held in abeyance in case any shortage should develop later.

This new enterprise for this section is the brightest opening for the farmer that could possibly happen, because of the good price assured him for his labor in producing the beets and the chance afforded of developing a new industry that will be of the greatest value to eastern Montana.

KANSAS.

Kansas was one of the first States to carry on extensive experiments for testing conditions favorable to the beet-sugar industry. These were conducted by the State experiment station at Manhattan. They were confined mainly to the more thickly settled and better developed eastern portion of the State, and in that part generally considered the corn belt and more secure from drought. At the time of these early experiments the western part of the State was generally considered better adapted to grazing; in fact, in this State, as in nearly all others, the original settlers had abandoned the western part, not considering it available for cultivated crops.

The results of these experiments originally conducted for the eastern section were generally considered unfavorable. For some years this verdict has been applied to the whole State; however, recent indications are more favorable for the western or semiarid portions.

The establishment of beet-sugar factories at Sugar City and Rocky-

ford, in the eastern part of Colorado, along the Arkansas River, has reacted more or less in determining conditions in the western part of Kansas. Beets in Colorado are grown under irrigation, water being secured from the Arkansas River. The beet industry has thrived, the factories in these districts receiving a good tonnage and a high quality of beets. This stimulated farming districts along the Arkansas River in the western part of Kansas to test the qualities of soil and natural conditions favorable to the beet-sugar industry.

Through influences exerted from the western end of the State the legislature passed a law paying a bounty of $1 per ton on all beets grown in the State. Under this enactment beets have been grown commercially, more or less, along the Arkansas River, and particularly in Hamilton, Kearney, and Finney counties, for the last four years. The crop has shown quite favorable results during these seasons, except in 1903, when a late spring freeze caught most of the young beets. During 1903 and 1904 the springs have been quite wet and unfavorable for all cultivated crops. Sugar beets have shown, as a rule, better results under these unfavorable conditions than most other crops grown in the same districts.

Under the influence of this bounty law there has been grown in the State, during the past four years, sugar beets as follows:

Year.	Acres.	Yield, tons.
1901	337	1,747
1902	439	4,250
1903	800	695
1904	692	6,379

In explanation of the above table, I will state that the large acreage and small tonnage for 1903 is due to destruction of the young beets by the freeze already mentioned, the ground being afterwards planted with other crops.

Beet production has progressed along the Arkansas River as far east as Arkansas City, which is on the southern border of the State and about one-third of the distance west from the eastern boundary. Under the direction of the commercial club of that place beets were grown last year, and the encouragement was sufficient to promote experimentation on a larger scale during this season.

It will be interesting to note that most of the beets in these districts along the Arkansas River were raised without the aid of irrigation. In the northwestern corner of the State, in the counties of Cheyenne and Sherman also, active interest was taken in beet growing this year. The results were probably as favorable for a first season as any ever secured in any of the beet-growing sections of Colorado or western Kansas.

Twelve years ago I paid a visit to the western part of Kansas and

eastern Colorado. It was just after the close of the apparently fruitless efforts of the original settlers to reclaim that portion of the country. The general verdict at that time was that the country must revert to the wild range for roaming herds of cattle and horses; for cultivated crops it was a failure. The abandoned fields, crumbling sod houses, and the departing settlers was a scene to elicit one's sympathy.

Experiences of recent years are demonstrating far better things for this section of the country. Recent visits demonstrate that the farmer with the plow is gradually penetrating this district and is here to stay. The change had its beginning in the irrigation facilities of the great Arkansas River, connecting the arid sections of the West with the green fields of the East.

Even when entirely dependent upon rainfall, farmers are gradually extending the cultivation of crops and achieving striking success under the circumstances. It is very encouraging to note the results in these western counties of Kansas which raised sugar beets during the past year. Here we find, with but little experience in beet growing, as high tonnage and as good average quality of beets as can be found in any other part of the country, whether water is furnished by irrigation or rainfall.

In order to secure the details of the work accomplished in these various places, I wrote to parties particularly interested in these beet-growing experiments and received the following reports, which I submit:

ST. FRANCIS.—This is the county seat of Cheyenne County, the northwestern corner county of the State. Beets were grown here by irrigation, the results of which are more particularly summarized by J. L. Finley, who reports as follows:

ST. FRANCIS, KANS., *December 19, 1905.*

DEAR SIR: Yours of the 17th received. There were six different growers in this territory this year: Myself, 15 acres; Jacob Uplinger, 32 acres; George Weidenheimer, 8 acres; Mark Weidenheimer, 5 acres; Deroy Danielson, 15 acres; Josiah Crosby, 9 acres. The post-office address of all is St. Francis.

The beets from these fields have averaged a little upward of 13 tons per acre. The average cost per acre was about $30. We have received $5 per ton from the factory and expect a bounty of $1 per ton from the State.

All these beets were raised under irrigation. While there was plenty of water, it was not applied to the best advantage, as we have all learned since.

This is the first experience of all the raisers here, and I feel satisfied that the results are not to exceed half of the possibilities.

As to percentage of sugar and purity, we have not received a report of this yet. I sent in a sample nearly a month before harvesting and the factory reported 14.3 per cent sugar. I have since learned that the beets from here were testing 16 to 17 per cent sugar. The purity is also high. I can not give you figures now. In the meantime, however, I have no doubt you can get them from The Standard Beet Sugar Company, Ames, Nebr. I will be glad to assist you at any time.

Respectfully,

J. L. FINLEY.

In this locality there were 16 growers, harvesting 106 acres. The total yield was 1,487.7 tons, an average of 14.3 tons per acre. The total value of the crop was $7,438.50. One grower produced 387.9 tons from 33 acres, averaging 15.3 per cent sugar. For the crop off the 33 acres he received $1,949. His beets averaged 11.7 tons and brought $58.50 per acre.

ARKANSAS CITY.—At my solicitation, the Commercial Club of Kan sas City had Mr. E. Kirkpatrick, chairman of the home industry committee, forward me the following report:

ARKANSAS CITY, *December 30, 1904.*

DEAR SIR: Inclosed please find copy of this year's test in sugar-beet growing in this vicinity, giving the name and address of persons growing beets, per cent of sugar and coefficient of purity. I can not give you the tonnage, as the beets were grown in small tracts of one-half to 1 acre. We shipped one carload from Kildare, Okla.; one from Arkansas City, Kans.; one from Portland, Kans., to the American Beet Sugar Company at Rockyford, Colo., at a flat rate of $5 per ton.

The experimental work of growing sugar beets in this vicinity has been conducted by our commercial club. Our object is to locate a beet-sugar factory in this city. We feel very much encouraged from the present outlook and believe we will be successful. The spring of the year was rather unfavorable for growing beets on account of too much rain.

We contracted for and furnished seed for about 50 acres. I think I am safe in saying 85 per cent of the 50 acres were lost on account of the heavy rains, and this test which I send you is from about 15 per cent that succeeded in carrying their beets through the wet weather. The midsummer and fall proved very fine weather for the beets, and this splendid showing is the result:

Locality.	Grower.	Per cent of sugar.	Coefficient of purity.
Arkansas City, Kans	E. C. Crampton	12.4	70.8
Do	Fred Trimper	13.75	76.4
Do	Fred Demott	15.2	78.8
Do	J. H. Campbell	14.6	78.9
Do	W. C. Baker	16.5	82.5
Do	H. M. Griffith	13.6	78.8
Kildare, Okla	H. C. Gentry	14.2	77.6
Do	S. Spore	16.0	82.0
Do	Fred Smith	14.9	80.6
Do	F. R. Summers	14.4	80.0
Newkirk, Okla	Scott Wolfe	15.3	78.8
Do	O. L. Zook	15.0	66.5
Ponca City, Okla	B. L. Long	13.1	74.8
Do	G. M. McGee	16.0	80.8
Do	A. W. Hawkins	16.2	79.8
Do	Coates Bros	14.5	77.1
Portland, Kans	R. H. Behimer	15.0	75.3
Do	H. A. Young	14.5	78.8
Do	R. M. Brooks	15.0	77.3

It will be noted from the above table that for experimental beets grown by inexperienced farmers the sugar contents are very high. The indications of this table are that when beets have been grown for some time in this locality it is capable of producing those of high grade.

EMPORIA.—Emporia is in the eastern part of Kansas, in the corn belt. Experiments have been actively carried on during the recent revival of interest on this subject in the State. From Mr. Eli Fowler I have received a report of the results of experiments conducted in

that vicinity during the past year. This I insert below. It constitutes a very favorable showing of results during this season, averaging in sugar content 14.6 per cent with a purity of 81.3. If beets like these of sufficient tonnage could be grown yearly in eastern Kansas, there is no question about the conditions in this part of the State being favorable to the sugar industry. Since that county receives a bountiful supply of rain, beets could be produced at considerably less cost than beets of like quality in the irrigated sections of the country. Mr. Fowler's report is as follows:

EMPORIA, KANS., *December 29, 1904.*

DEAR SIR: Replying to your favor dated December 31, received by me a few days ago, I would state that the sugar-beet industry in our section is as yet only in the experimental stage. For the two seasons last past we have conducted experiments under the direction of a county association, but both years have been exceptionally wet—almost a total failure of every other crop on account of the wet weather—and we have been handicapped on this account.

We have not conducted our tests with a view to determining the tonnage per acre of our beets. Our soil is such that we can raise enough beets should we attain the percentage of sugar and purity. We shall make further tests next season, with a hope that we may have a favorable season, so that our tests may be more conclusive.

We have no immediate prospect for a factory. Our tests have been conducted by the American Sugar Beet Company, of Rockyford, Col.

We are inclosing a table of the tests of last year's crop.

Grower.	Per cent of sugar.	Coefficient of purity.
H. T. Pickett	16.2	84.8
David Rees	14.2	80.2
H. J. Painter	14.5	81.4
L. Faulkner	14.6	80.5
H. R. Martin	14.4	78.0
A. D. Wilhite	14.1	80.1
J. W. Fowler	16.0	83.7

FINNEY AND KEARNEY COUNTIES.—In Kearney County the beets were grown mostly in the neighborhood of Deerfield and Lakin. From Lakin were shipped about 88 cars; 300 acres were planted to beets. The average was about 14 tons per acre. The following is a list of the growers around Garden City, Finney County, with the number of pounds of beets produced by each, making a total of 432.5 tons:

	Pounds.		Pounds.
Huffman	57,115	Diesem	75,630
Doty	89,165	Miles	35,420
Wash Jackson	20,530	Frank McCue	22,275
Baker	41,840	Pennington	53,180
Logan	43,520	Owens	125,810
Carpenter	177,780	Robertson	1,900
Carter	51,690	Total	864,910
Maroney	47,130		
Jerry Lewis	21,925		

With reference to some of the growers, the Topeka Capital, under date of December 1, has the following to say:

Jim Owens has finished loading his third car of sugar beets; total yield shipped, 125,810 pounds—over 62 tons from 4 acres, besides feeding 22 shoats that will now weigh 120 pounds, and some larger hogs, for which he believes 10 tons should be added to the yield. Allowing $25 per acre for expense, this gives him net $45 per acre.

It is hardly likely that the sugar-beet bounty will be continued another year. The industry is now well on its feet. Therefore in making contracts for the years to come the bounty will cease to be a factor. Growers and the beet company will have to govern themselves accordingly.

It is probable that inside of two years a factory will be established in western Kansas, somewhere on the Santa Fe line.

Manuel Baker, from 1⅛ acres, raised 26 tons of sugar beets. At the market price, $5 per ton, this would make $115.55 per acre, windmill irrigation supplying the moisture.

In addition to the yield as shown by scales, Wilson Carter has fed to hogs and now has on hand enough to make his showing 31 tons per acre.

Under date of December 13, the Kansas City (Mo.) Journal contained the following:

SUGAR BEETS $100 AN ACRE—NEW INDUSTRY A GOLD MINE FOR SEMIARID DISTRICT OF KANSAS.

LAKIN, KANS., *December 12.*—The sugar-beet harvest is over in the Arkansas Valley. Final shipments have been made to the sugar mills in Colorado. The weather throughout the harvesting has been fine. The shipments from Lakin aggregated 1,000 tons, and from Deerfield 4,000 tons, making 5,000 tons from Kearney County, or over 9,000,000 pounds of beets. This exceeds the big crop of 1902, which was 8,501,400 pounds, and is nine times as large as the crop of 1903.

The discouragements of last year are now banished by the remarkably fine crop just harvested. The present crop was seriously threatened by grasshoppers in the early spring months, and they did destroy several fields of beets around Lakin. Had it not been for the constant and vigorous war made on this unusual swarm of hoppers, other farmers would have met defeat in the loss of their chief money-making crop. As it is, 1904 exceeds all past yields, and makes it the most profitable crop that can be grown here.

It would take three years, and a fortune invested in cattle and lands, to grow 1,000 head of steers at $30 per head, to bring as much money as these Kearney County farmers realized from 300 acres of beets in one season.

The Topeka (Kans.) Capital, January 1, with reference to beet growing in the State, has the following to say:

A significant feature of the 1904 production is that over 25 per cent of the crop was grown in territory not before assumed to be suitable, viz, in the three extreme northwestern counties of Cheyenne, Rawlins, and Decatur, and also in Cowley County, 200 miles farther eastward than beets had before been grown for sugar in the Arkansas Valley. In the latter instance the experiments were made under the supervision of the Arkansas City Commercial Club, whose members are reported as being "very enthusiastic" over the results.

* * * * * * *

The cost per acre reported by 16 growers ranges from $15 to $46.50, and the greatest net profit per acre, exclusive of bounty, is $90. The largest yield per acre is 23.1 tons.

Following is the official list of growers of sugar beets during this season in the State of Kansas, with the pounds produced and bounty received by each, under the laws of that State:

Results of growing sugar beets in Kansas in 1904.

Post-office and grower.	Pounds of beets.	Bounty.	Post-office and grower.	Pounds of beets.	Bounty.
Lakin:			Deerfield—Continued:		
H. K. Beehn	158,000	$79.00	M. D. Biehn	562,000	$281.00
A. G. Campbell	358,000	179.00	Buell Bros	478,000	239.00
Carl Coerber	470,000	235.00	J. W. Bell & Son	104,000	52.00
A. E. Cross	150,000	75.00	R. A. Beckett	342,000	171.00
Wm. Day	68,000	34.00	C. L. Beckett	446,000	223.00
Benj. F. Dye, sr	66,000	33.00	H. A. Coerber	132,000	66.00
John F. Entz	104,000	52.00	S. H. Corbett	46,000	23.00
R. M. Edmiston	34,000	17.00	O. J. Downing	156,000	78.00
Henry Entz	278,000	139.00	W. E. Downing	78,000	39.00
H. F. Entz	128,000	64.00	J. S. Friesner	674,000	337.00
Frans Faldtz	134,000	67.00	A. J. Gillock	480,000	240.00
Nathan Fulmer	76,000	38.00	H. Gillogly	122,000	61.00
F. R. French	16,000	8.00	R. D. Glass	82,000	41.00
F. A. Gulick	152,000	76.00	Fred Hurst	50,000	25.00
Jacob Halloway	32,000	16.00	C. H. Hartman	10,000	5.00
Oscar Hurst	130,000	65.00	T. J. Isaacs	280,000	140.00
Chas. A. Hawk	46,000	23.00	Wm. T. Kell	192,000	96.00
William Logan	126,000	63.00	H. F. Kriete	46,000	23.00
D. H. Camp	22,000	11.00	J. T. Kell	186,000	93.00
Joseph McCoy	108,000	54.00	C. S. Logan	326,000	163.00
E. F. Miller	106,000	53.00	Adam Moltz	108,000	54.00
Thos. D. Nash	150,000	75.00	J. C. McConaughey	52,000	26.00
Jacob Regehr	60,000	30.00	J. R. Woodward and H. F. Faldtz	100,000	50.00
H. C. Stocking	72,000	36.00	A. D. White	242,000	121.00
G. C. Smith	46,000	23.00	Commercial Club of Arkansas City	50,000	25.00
A. W. Sudduth	16,000	8.00			
Newton:			Traer:		
J. M. Root	128,000	64.00	E. E. Schultz	82,400	41.20
Garden City:			Irvin Robinson	133,000	66.50
S. E. Austin	18,000	9.00	John J. Holmes	128,200	64.10
M. M. Baker	44,000	22.00	D. S. Yost and J. Walton	177,400	88.70
Wilson Carter	46,000	23.00	Herndon:		
Samson Carpenter	142,000	71.00	E. Farry	51,800	25.90
Lee L. Doty	80,000	40.00	Joseph Brown	105,800	52.90
I. L. Diesem	80,000	40.00	Mary Brown	48,000	24.00
W. J. Ellis	12,000	6.00	J. P. Jentges	53,200	26.60
S. D. Huffman	50,000	25.00	B. H. Scheve	138,600	69.30
Wash. Jackson	18,000	9.00	Frank Studer	46,000	23.00
Jerry Lewis	16,000	8.00	St. Francis:		
D. H. Logan	42,000	21.00	Josiah Crosby	232,000	116.00
E. H. Miles	42,000	21.00	D. Danielson	327,200	163.60
P. N. Meroney	46,000	23.00	John L. Finley	384,000	192.00
Frank McCue	18,000	9.00	Jacob Uplinger	775,800	387.90
J. L. Owens	116,000	58.00	G. S. Weidenheimer	144,000	72.00
Frank Pennington	46,000	23.00	Mart Weidenheimer	148,000	74.00
Deerfield:					
J. L. Couch	176,000	88.00	Total	12,759,400	6,379.70
B. A. Bruce	214,000	107.00			

NEBRASKA.

There has been considerable agitation during the past year, tending to increase the beet-sugar industry in the State of Nebraska. Next to the one at Alvarado, Cal., the factory at Grand Island, Nebr., was the second factory successfully operated in the United States. Another followed at Norfolk the next year. Nine years later another one was built at Leavitt, near Ames, on the Union Pacific Railroad, about 50 miles west of Omaha. This gives Nebraska fourteen years' experience in beet-sugar production. Beets for these three factories are grown in districts where crops are produced by rainfall. In the fourteen years the State has developed considerable of the information covering beet growing in rainfall districts.

There were many things in the early days restraining the progress of the industry. The State offered a bounty for all sugar manufactured in the State. Litigation as to the constitutionality of this law arose between the management of the factory and the State auditor. The matter has been under a contest for a number of years, the State refusing to pay the bounty. Finally the supreme court, during the past summer, rendered a decision against the sugar company. No doubt the factories at Grand Island and Norfolk were inspired originally by the offer of this bounty.

Considerable friction occurred between the management and the farmers growing beets. Two or three years' drought caused poor crops. Then better seasons, more favorable to beet growing, followed. Later came an attack on the beet crop by a disease generally denominated "beet blight." This produced another poor year for the farmers. All these things had a very great tendency to discourage the industry in the State. During all their pioneer experience the factories established in Nebraska passed through very trying ordeals. It became necessary to close down the factory at Grand Island for a couple of campaigns, until these difficulties could be overcome or adjusted. Beets grown for this factory were shipped to Norfolk.

Coupled with the natural difficulties attending the pioneer experience of these factories was the one spoken of so often—general lack of experience in growing beets and appreciation of the benefits of a successfully operated sugar factory. The obstacles were so various and continued that it took considerable time to institute a fairly favorable normal condition of things.

During the time stock interests of the localities were very much increased and improved generally, especially around Norfolk and Grand Island. Originally the pulp by-product was thrown away, or deposited out on the prairies; I saw some of this same pulp fed to stock four years afterwards. This fact has always been a strong evidence of its keeping qualities. Around Grand Island at present many thousand head of sheep and cattle are fed annually. This is due to the pulp supply of the sugar factory. Large feeding and dairy enterprises sprung up around Norfolk, also due to the same causes.

It was the policy of this company, in encouraging beet production, to furnish no pulp except to those growing beets. Finally this became a very strong incentive to induce the farmers to raise beets. During the seasons in which the beets grown at Grand Island were shipped to Norfolk, I observed a very striking illustration of the value of beet pulp. Many of the farmers and feeders of Grand Island insisted on the pulp being shipped back to them at Grand Island. The freight alone on this pulp, from Norfolk to Grand Island, was something like $1.25 a ton. This demonstrates that some, at least, of the farmers and feeders learned to appreciate its value. The incentive for

building the factory at Leavitt was that of securing the pulp for feeding the stock of the Standard Cattle Company. This company annually feeds thousands of head of cattle or sheep, being one of the largest establishment of the kind in the West.

All three factories in the State of Nebraska have been operated through continuously improved conditions for the past four years. Each of these factories during the last campaign had more and better beets than at any other time in its history. Many of the farmers have come to understand the incidental benefits of the sugar industry, and are becoming larger and more regular contributors to the supply of beets. They have noted the improvement of their farms and their increased facilities for stock raising and cropping generally.

In the western part of Nebraska, large tracts of land are coming under cultivation, stimulated by the introduction of irrigation. It is found that beets are well adapted to the conditions and a most profitable crop, and they are becoming the leading crop in two or three counties. The beets have been grown under contract and delivered to the factories farther east at Grand Island, Leavitt, and Norfolk. As a rule these beets are high in sugar content, the tonnage is large, and they yield a larger profit than any other crop grown in this western section. They also enter very nicely into rotation with other crops grown there, principally alfalfa, and small grain.

The centers surrounded by these beet districts in the western part of the State are North Platte, in Lincoln County; Culbertson, in Hitchcock County, and McCook, in Red Willow County. More beets are now grown in Lincoln County, around North Platte, than in any of the counties having sugar factories. Each one of these places is earnestly endeavoring to establish a factory. This is in accord with the policy I have mentioned before of building new sugar factories in districts where beets are grown extensively for other factories. There can be no mistaking natural conditions under such circumstances. While these western districts, for a few years, have been helping to augment the supply of beets for the factories farther east, the factory managements have been steadily building up their local supplies. Both the Standard Sugar Company, at Leavitt, and the American Beet Sugar Company, at Grand Island, have been contemplating the erection of factories in the new western districts which they have developed.

The removal of the plant from Norfolk, Nebr., to Lamar, Colo. (which is now in process), has excited considerable discussion throughout the country. Many seem to take it for granted that the beet-sugar industry in Nebraska is a failure. Because this plant has been established about fourteen years, and then moved to another State, it seems proof positive to many that conditions in Nebraska will not sustain the sugar industry. If it were not for the facts, it might be logical to assume that such is the case.

I have not been advised as to the real purposes of the American Sugar Refining Company in moving its plant from Norfolk to Lamar, but I take it that it was not from a failure of the plant, but that the move was more in keeping with the policy the company maintains. This plant goes to a location near Rockyford, where this company has another large plant. The one at Rockyford has built up a large beet-producing district. For this plant the Lamar section had been growing beets quite extensively for two or three years. It is demonstrated that Lamar is a very desirable location for a sugar factory. Surrounding it are cheap lands, which can be purchased for a small price per acre. With the aid of irrigation these lands become very productive and valuable. In establishing its recent factories, this company has followed the plan of acquiring a large tract of land connected with the plant.

For the American Beet Sugar Company it is purely a matter of business sagacity to locate at Lamar; otherwise the district it had developed would be invaded by others interested in factory building. Located at Norfolk, Nebr., the factory was practically isolated; the lands are high-priced; it had taken this company considerable time to work up local interest to the point of promoting its successful operation. It is not likely the company would want to build another factory in the vicinity of Norfolk.

For three years Norfolk has had a good supply of beets and successful campaigns. The last was the best in the history of the factory. It began operations October 4 and continued until December 10. This gave it about seventy days, running at full capacity. It would be hard, with such facts as these before us, to demonstrate that the factory at Norfolk retired from that field for want of beets or for lack of profitable work. The factory has built up during these years conditions making its work much more easy and profitable. It was, however, destined to confine its operation purely to sugar making, while in its new field it will serve its owners better, not only in sugar making, but in developing the agricultural resources of a large district.

Farther east of its new location, its owners have been closely studying a district in Kansas with conditions similar to those at Lamar. It is quite probable that they will locate a factory in this Kansas field. West of Lamar, and equally distant from Rockyford, they have been studying carefully the conditions at Las Animas. A factory at each of these places would give them a chain of plants along the Arkansas River, working beets produced by their own irrigation systems, all building up values of lands and rents, towns, railroads, and auxiliary improvements of various kinds, all of which will redound materially to the benefit of the owners of the Norfolk plant removed to Lamar. So I think it is not a question of how well the Norfolk plant was doing in Nebraska, but how much better it will do in Colorado.

The new factories in Nebraska in the near future will be erected at some of the western points recently developing through irrigation.

NORTH PLATTE.—A plant has been contemplated at this place for some time. Its conditions have been thoroughly tested by growing beets for the factories of both the American Beet Sugar Company and the Standard Beet Sugar Company. It has grown in one season as high as 4,200 acres, practically equally divided between the two companies.

Beets at this place have tested as high as any in the country. Considering wagon and carload lots, it has the highest record of quality of any place in the world. The yield has been quite satisfactory also, running easily from 10 to 20 tons per acre.

The valley from North Platte to Paxton is about 33 miles long and 5 miles wide, all of which area is subject to irrigation, and consequently is adapted to beets and other crops. The locality has soil and conditions highly satisfactory for producing beets. The great drawback is insufficient farmers and laborers to do the work.

Each one of the companies growing beets here has announced that it will install a factory as soon as enough settlers and laborers can be attracted to insure field hands to grow the beets needed by the plant.

McCOOK.—The conditions around McCook are quite similar to those described for North Platte. This place continues to grow sugar beets extensively for the factories farther east in the State. The beets show good yield, quality, and purity. Lack of farmers and laborers sufficient to furnish a factory with a supply of beets is the main difficulty, the same as at North Platte. The vicinity has sufficient land under irrigation to grow the beets and other crops entering into the rotation.

There are several parties interested in this locality prepared to install a sugar factory when conditions are favorable. This district is watered by irrigation from the Republican River. The farmers have been growing beets to a considerable extent for the last four years. During this season the district grew enough beets to run an ordinary factory of 350 tons during an average campaign.

Below I publish a report from E. E. Maxon, the agent and superintendent of the Standard Beet Sugar Company, in charge of the work of growing beets in that locality for this company:

McCOOK, NEBR., *December 28, 1904.*

DEAR SIR: Your communication regarding sugar-beet culture in this locality was handed me a few days since. Replying to same will say that we have passed the experimental stage, and have grown beets successfully for the last two years.

In 1900 there were about 400 tons grown in the Republican Valley. This year there have been 25,000 tons grown, at $5 per ton, between Oxford and Haigler, Nebr., including the Frenchman Valley.

Prospects for a factory are good, but we must get more people located here and lands worked in smaller holdings, with a better class of husbandry. Our com-

pany has agreed to build a factory as soon as developments will justify. The quality of beets grown is good, averaging about 15 per cent sugar, with a purity of about 80.

To give a list of growers would require some time and work, there being 300 or more.

Yours, respectfully,

E. E. MAXON, *Agent.*

CULBERTSON.—What has been said about conditions around North Platte and McCook is practically applicable to this place. It has the same conditions of soil and climate. Given sufficient water it produces beets of high grade, like the other two. It is in Hitchcock County, on the Republican River, which flows through the central part of the county from west to east and is joined by the Frenchman River at this point. These two rivers afford considerable opportunity for irrigation.

Considerable quantities of beets have been grown for factory purposes, the same as in Lincoln and Red Willow counties. While it is possible that factories will be located at the other two points first, it is also highly probable that this place will be the next in line. It has the available territory, water, and all the conditions for maintaining a sugar factory when it secures the settlers and laborers necessary to accomplish the work of growing beets and other crops.

UTAH.

Utah has had considerable agitation this year pertaining to the extension of the beet-sugar industry. Building new factories in the State is attended with the usual conservatism.

Taking into account the population of the State it has already developed large interests in beet-sugar production. Up to date this has been accomplished by two companies—the Utah Sugar Company and the Amalgamated Sugar Company. The Utah was the first in the field, erecting a factory at Lehi thirteen years ago. Working in conjunction with this plant are three slicing stations connected with it by pipe lines conveying the juice to the main plant in Lehi. In addition to this plant and its auxiliaries the company operates another plant at Garland, in Cache County, in the Bear River Valley, in the northern part of Utah. It also operates two others in the western part of Idaho. The Amalgamated operates a factory at Ogden and another at Logan, both in the northern part of the State; also one at Lagrande, Oreg.

The State presents many advantages for this industry. It was one of the first in the field to attempt manufacturing sugar from beets. The operations of this concern, through its long experience, developed much of the early information bearing on the subject, of which not only the new concerns in the State but all others in the Rocky Mountain irrigated sections are the beneficiaries.

Probably the history of the factory at Lehi best illustrates the general experience of the beet-sugar industry in the irrigated sections. It is now one of the most successfully operated plants. In the beginning it encountered many vicissitudes due to general lack of experience.

All the beets in the State are grown by irrigation. The supply of water for field crops is dependent largely on winter snows. When these are bountiful a good season is anticipated in the State. More or less rain falls during the spring season. Irrigation is applied when necessary to supplement the moisture from rainfall.

Throughout the agricultural sections the farms are usually of small size. Owing to the peculiar policies of the people originally settling the State, intensive agriculture is the rule. The early settlers who secure a sustenance off these small farms are accustomed to hard work. They have a labor system peculiar to the Mormon sect admirably adapted to their needs. A sugar factory thrives best when surrounded by small farms, and especially when these farms are operated by people accustomed to methods involving intensive cultivation.

As a rule the irrigation districts are supplied from small streams of water flowing down the canyons directly from the melting snows of the mountain. The people are not only utilizing water for growing crops in the valleys, but are utilizing the power of these mountain streams as they flow down the gorges. This power is applied industrially in many forms; it is especially employed in facilitating the sugar industry, propelling interurban lines, and in furnishing light, power, and other facilities.

The lesson taught through the experience of the first factory has borne fruit conducive to more conservative plans in those that have followed. Additional factories in this State have been installed only in districts where conditions have been fully developed, where everything necessary for sustaining the beet-sugar industry was fully understood in advance. Each of the sugar companies follows a well-defined policy in the operation of its factories, building up an ample beet-growing territory before establishing a new factory. Agitation or pressure for new plants comes from the farming districts rather than from the factory. The beet-growing inclinations of the farmers have outrun the capacity of the factories, and others are desired.

In the State, stock feeding, dairying, and other interests feel the influence of the sugar industry, and have been built up with it. Indications point to conditions favorable for installing two factories in the State in the near future.

GUNNISON.—Extending south from Salt Lake City, tapping centrally the agricultural districts of Salt Lake, Utah, San Pete, and Sevier counties, is the Rio Grande Western Railroad. On this railroad, about 30 miles from Salt Lake City, near the large fresh-water lake known as Lake Utah, is the Lehi factory. This factory has been sup-

plied with beets from a large agricultural district, made up of various valleys throughout these counties.

From farther south beets have been delivered by railroad; also some of the beets in the territory nearer to the factory. For the purpose of facilitating the delivery of the raw product to the factory, the plant has installed three slicing stations in different directions, at distances varying from 12 to 20 miles over the railroad. On account of scarcity of cars during the beet-delivery season the plant was hampered many times in securing its supply of beets. This was occasioned by large shipments of ore and other material requiring the attention of the railroads at the particular season when the beets had to be shipped. The pipe lines running from these slicing stations to the factory have completely eliminated the trouble for the localities possessing the slicing plants. But the district south of the factory, included in Sevier and San Pete counties, has always experienced difficulty in shipping its beets on account of this scarcity of cars. The district is naturally quite favorably located for a sugar factory. It is approximately 100 miles from the factory at Lehi. The management of the factory at Lehi has given the district considerable attention, evidently intending at some time in the future to construct a plant at some central point.

Beet growing has become so popular with the farmers in these counties that they are exerting pressure tending to influence the early installment of a beet-sugar plant. Negotiations have been opened with outside parties. Having spent considerable time and money developing the district, the management of the Lehi concern naturally feels this to be an invasion, and that, if a new plant is to be constructed, it should be a part of the Utah Sugar Company's system.

Considerable agitation has proceeded among the farmers and business men of this section with a view to the immediate building of a factory. Several meetings have been held during the summer. Negotiations have been conducted with other parties besides the Utah Sugar Company. Mr. B. F. Locker, of Salt Lake City, representing eastern capitalists, made a proposition to install a plant at this place of 750 tons daily capacity, provided 6,000 acres of beets are guaranteed. This plant is to have sufficient slicing stations to accommodate the whole district in Sevier and San Pete counties. A mass meeting made up of 125 farmers, representing all the precincts of these two counties, except two, was held. The convention, in the interest of the district, accepted the proposition made by Mr. Locker. It voted to hold another meeting at an early date for the purpose of meeting those represented in financing the project and to arrange the details of its installation. The matter has naturally aroused more or less controversy on account of the interest of the Utah Sugar Company.

In view of the extent of beet growing in this district, and the interest it has aroused on the part of investors, it is settled that either the Utah Sugar Company or Mr. Locker will build a factory in this district for the campaign of 1905.

LEWISTON.—As in the case of Gunnison, there is a rivalry of interest in the building of a beet-sugar factory at Lewiston. This is on the Cub River, in Cache County, about the central part of the State east and west, and near the northern line. It will draw its beet supply from Cache County on the south and Idaho on the north, as it is situated near the State line. The factory of the Amalgamated Sugar Company at Logan is located about 30 miles south. Beets have been grown quite extensively in the county for this factory. The management of this enterprise has given more or less attention to the Lewiston district and its interest in a new factory. It appears that the Logan interests look upon Lewiston as a possible future location of a sugar factory; also, that they think the immediate building of one would be premature.

Other parties have been actively considering the project and negotiating with those of local interest at Lewiston. Assurances were given publicity several times in 1903 that plans had already been arranged for the establishment of a factory. There has been considerable revival of this talk. It seems quite certain that out of this, some time in the near future, a factory will be established at this place either by Amalgamated interests or others.

The Logan (Utah) Journal, under date of December 3, has the following to say:

> The prosperous town of Lewiston is in the throes of a rather acute excitement over the strong probability that the proposed beet-sugar factory will be built at that place in time for operation next year. In fact, current reports are to the effect that the matter has been definitely settled and that there is no longer any doubt of the enterprise being pulled off. It is said that the location has been decided upon and that the plant will be built on the creek on the east side of the town site, just immediately east of Oscar A. Pope's ranch. This will make Webster's spur the nearest railroad point at present. Of course, the factory people will construct tracks to the plant.

WASHINGTON.

The claims of the State of Washington in establishing the beet-sugar industry are beginning to be appreciated. Like many of the mountain States, its agricultural awakening is of recent date. In the past it has been grazed and sown to wheat and small grains in large fields.

It has great mining resources and lumber interests. Through these and its oriental and Alaskan shipping it first received its great prominence. There are beautiful fertile valleys among its mountains and expansive table-lands in the eastern part, all arable and fertile to a remarkable degree. Its resources are so vast and numerous that it is denominated by tourists "the Pennsylvania" of the Pacific coast.

For some years experiments have been carried on to test its conditions for growing sugar beets. In the State a factory was installed, at Waverly, in 1899. Like many new and undeveloped sections of the country, its great difficulty has resulted from the sparseness of its population. On account of the small amount of labor required, it is easy to sow large fields of wheat and graze large herds of cattle.

Many places in the State have shown ideal conditions for the sugar industry; but before these can be utilized more highly developed conditions must prepare the way. A large amount of pioneer work in other directions is needed to pave the way for the projects contemplated in the State. Irrigation ditches are necessary and railroads and settlers. Fortunately, the promoters of the beet-sugar propositions in the State were wisely guided by the experience of other parts of the country.

The factory at Waverly demonstrated many things regarding the installation of the sugar industry in Washington. In the first place it has revealed ideal natural conditions so far as the soil and climate are concerned. It has met with considerable difficulty, however, on account of lack of the other facilities. It is hard to make an intensive farmer out of a wheat grower or a grazer or a miner. It has felt sorely the lack of a more dense population—more and better trained men in the beet fields. Its progress has been slow but steady.

Fortunately the plant was controlled by a man accustomed to building railroads in new undeveloped districts, and awaiting the progress of development to reward him for his energy and foresight. He has followed the same course with the sugar factory. It has required great energy, faith, and business tenacity to pull the sugar enterprise up from its beginning to its successful status of to-day. So far as systems of agriculture and applied methods in the fields are concerned it required the remaking of the factory's environment.

Beets grown in this district, properly cultivated, are of high quality. Located in the vicinity of this factory is an extensive garden-seed producer. This gentleman was impressed with the high quality of beets grown in the vicinity. He concluded that the conditions were favorable to producing high-quality beet seed and this would extend his seed business. Following a careful system of physical selection, he began the production of beet seed. He had not the facilities, chemical laboratories, etc., maintained by the foreign beet-seed grower. His first product of seed demonstrated higher qualities than any of those imported from foreign countries with all their scientific accoutrement, care, and attention. His seed produced beets averaging 19 per cent in sugar. They were very strong in vitality, yielding many more germinations per 100 and in shorter time than the seed generally imported.

I mention this in connection with the State of Washington, because

the work this gentleman has started is receiving the cooperation of the Department of Agriculture. Producing beet seed in this country suggests the possibilities of a great future industry. It is intimately associated with vital improvements to the beet-sugar industry itself. It is a part of the industry's development in the State. Its results also indicate the favorable conditions of the State.

YAKIMA.—The further extension of the industry in Washington seems most likely to occur at Yakima. A company has been organized, known as the North Yakima Beet-Sugar Company. The incorporators of the company are Jacob Furth, C. J. Smith, J. W. Clise, Lester Turner, I. A. Nadeau, C. W. Adams, and C. L. McMahan, all of Seattle; T. B. Wallace, Tacoma; Edward Whitson and G. S. Rankin, of North Yakima. The board of directors consists of Jacob Furth, C. J. Smith, J. W. Clise, Lester Turner, I. A. Nadeau, C. W. Adams, T. B. Wallace, Edward Whitson, G. S. Rankin. Six of these men are bankers. Mr. Nadeau is the general agent of the Northern Pacific in Seattle. Mr. Whitson and G. S. Rankin are business men of Yakima.

The capital stock of the company is $1,000,000, divided into 10,000 shares of $100 each. The company purposes establishing several plants, the first at North Yakima, to be followed by others at Prosser, Wenatchee, and Puyallup.

According to the articles of incorporation, the purpose of the company is to manufacture sugar, molasses, sirup, beet pulp, alcohol, vinegar, wood alcohol, glue, glycerine, acetate of lime, and all other by-products of sugar beets. The company is to acquire water rights, construct electric power and light plants, buy farming lands, and engage in all the auxiliary branches of industry of a manufacturing corporation.

The site chosen for the factory is near North Yakima, and consists of 80 acres located on the Northern Pacific. It has ample side tracks, shipping facilities generally, and a water right guaranteeing sufficient water to meet all the needs of the plant. The factory is to have a capacity for slicing 600 tons of beets daily, and is to be completed in time for the campaign of 1905. Contracts have been arranged for 5,000 acres of beets.

In order to gain the latest data with reference to the beet-sugar enterprise at North Yakima I wrote Mr. Henry B. Scudder, of that place, who reports, under date of December 28, as follows:

NORTH YAKIMA, *December 28, 1904.*

DEAR SIR: There have been few experiments in beet culture here this year. The beets raised in the Moxee Valley yielded at the rate of 30 tons to the acre. Samples were sent to the St. Louis Fair to be inspected. We are at present securing the acreage for a beet-sugar factory, and the matter is practically closed.

Yours truly,

HENRY B. SCUDDER.

WISCONSIN.

During the past year activity in promoting and extending the beet-sugar industry has been more extensive and general throughout Wisconsin than any other State. In 1901 a factory was installed at Menomonee Falls. The career of this concern has been very highly satisfactory from the beginning. In growing sugar beets and manufacturing sugar it has done much to develop the general conditions and resources of the industry in the State.

From the first inception of the industry in the early days the promoters of the beet-sugar industry looked favorably upon Wisconsin. A factory was installed at Fond du Lac thirty-six years ago. It achieved considerable success, but was finally moved to the western coast on account of better facilities for securing capital, labor, etc.

The management and capitalists of the factory at Menomonee Falls have adopted the policy of gradually establishing other plants as the operations of this one pave the way. With this in view, considerable acreage of beets has been contracted at favorable points, such as Chippewa Falls, Janesville, Watertown, and one or two other places. It is the policy of this company, through this method, to thoroughly test agricultural districts, and at the same time educate the farming and business community in regard to the methods and requisites of a factory.

In the following interview in the Milwaukee Sentinel, April 5, the manager of the Menomonee Falls factory, Mr. R. G. Wagner, discloses this policy:

> Wisconsin will be a great producer of sugar as soon as its vast areas of land become more densely settled. There is room enough for at least 30 factories, but the trouble is there is not enough labor to be had to raise the necessary beets that will be needed by the factories.
>
> Beet culture requires a study of several years before the farmer is enabled to raise the kind that makes good sugar, and for this reason I do not think a factory will be built at Eau Claire in the immediate future. We have a factory at Chippewa Falls that will be ready this fall (1904), and that will take care of 600 tons of beets daily during the four months it will be in operation; but the beets that it will consume will come from almost every part of the State. We have farmers growing beets for us wherever the soil is such as to warrant the experiment, and when we find the farmers are sufficiently ambitious to make a success of the venture we will erect a factory; but for the present we shall content ourselves with the two in which we are now interested—the one at Menomonee Falls, which has been in operation with unqualified success for the last three years, and the one at Chippewa Falls.
>
> We had intended to put up a plant at Janesville, and have not yet given up the idea entirely, even though Captain Davidson has been induced to move his Canadian factory to that place. We find that at present not enough beets are grown there to keep a factory busy for two months. We are also experimenting with farmers in Dane County, and I think we may eventually put up a factory in that district, as the farmers thereabouts have shown a special aptitude for beet growing.

Following this policy, this company has built up quite extensive beet-growing interests around Chippewa Falls and Janesville. Each

of these districts demonstrated capabilities for producing beets of desirable quality and in quantity sufficient to sustain a sugar factory. In pursuance of the plan, the parties interested in the factory at Menomonee Falls built a factory at Chippewa Falls during the past season and equipped it with the machinery previously used in the factory at Kalamazoo, Mich. The farmers and business men of Janesville had also become thoroughly interested in this subject; negotiations were inaugurated with the management of the factory at Dresden, Canada, conducted by Mr. Theodore Hapke, of Chicago, a beet-sugar factory promoter. Its interests were controlled by this gentleman and Capt. James Davidson, of Michigan. It appears that it was not receiving a sufficient supply of beets in its Canada locality; arrangements were therefore made to move it to Janesville, where it operated during the campaign of this year.

The success of the plant at Menomonee Falls, and the consequent development of beet growing around a number of centers throughout the State, stimulated by the work of the two new factories operating this season, has opened up a number of new fields, where the sugar industry is receiving serious consideration.

From time to time I have outlined the many favorable conditions and facilities for the beet-sugar industry in this State. It has extensive manufacturing interests. Like Michigan, it was once the field of active lumber production. The forests gave out, leaving combinations of business men with capital seeking something new. Its transportation facilities are ideal. It is penetrated in every direction by railroads. In its northern or unsettled portion these were installed to facilitate the lumber industry by transporting logs and lumber.

On the east it is bordered by Lake Michigan, upon which it has large commercial centers, communicating by lake shipping with Chicago and other extensive markets in its immediate vicinity. On the north it has Lake Superior and the great shipping system from Duluth, furnishing cheap transportation to Eastern markets. On the west it is bordered by the Mississippi River. Certainly with such advantages its position becomes commercially strategic. Reinforcing facilities of transportation and markets are many natural resources stimulating production—soil, mines, and mills.

Its agricultural resources are extensive. In the southern half of the State these are highly developed. It maintains many intensive interests. The two especially favorable for advancing the sugar industry are its creameries and its tobacco production. The one creates a demand for its by-products; the other develops the features of intensive agriculture.

Its cropping interests are admirably adapted to rotation and soil improvement. The legumes are especially productive, notably clover. This forage crop grows prolifically in all parts of the State. Unlike

Michigan is its development of dairy and stock interests. Also its methods of farming are much better adapted to fostering the industry from the beginning. Starting later the mistakes and difficulties characteristic of much of the work in Michigan will benefit the sugar industry in Wisconsin.

There are vast tracts of land in the northern third of the State unreclaimed. The woodman has denuded them of forests; the railroads are there, with small villages and hamlets denoting the former activity of the region. The methods for reclaiming these lands have been somewhat of a problem. These lands are covered with stumps and second-growth timber. A large part of it was originally settled by homesteaders, the balance passing into the hands of private owners through Government grants. Neither class of these original proprietors conceived a use for these lands other than their timber privileges. The settler sold off his timber to the sawmill, and in most instances moved off the land, allowing it to fall into the hands of the tax title speculator. The larger tracts have been collected by other speculators into still larger holdings.

Five years ago this was the general status of all that region of northern Wisconsin known as the "stump country." Gradually it has developed that these lands possess high agricultural utilities. Through natural seeding the whole face of this vast territory is becoming set to timothy and clover. Both of these grow luxuriantly.

Around the small towns and more settled portions along the railroads, small farms of a few acres have been cleared, upon which various kinds of crops have been grown. These have served the experimental purpose of disclosing the resources of all that part of Wisconsin.

It is found that the soil is very productive of many things in addition to those mentioned; small grains, root crops, and many varieties of fruits, especially winter apples. On account of its great drawback, the stumps, it has been slow in developing. Settlers have preferred lands like those of Kansas, Nebraska, the Dakotas, and the irrigated lands of the mountain States, in preference to these stump lands. The expense of removing the stumps is estimated to be from $5 to $40 per acre, depending upon the number, character, and size of the stumps.

The owners of these lands have been looking for a crop adapted to the section, that will reclaim it to profitable cultivation. Gardening will do it; but the region is too vast to plant entirely to garden products. Tobacco has done the work on some of it; but its progress has been slow, and it is not adapted to the northern part of the State. To clear land of stumps and plant small grains will not pay, because western prairies produce our best crops of wheat and other small grains simply by breaking the sod and sowing the seed. The culture of sugar beets seems best adapted to this purpose, and this crop is

gradually penetrating the stump fields of Wisconsin. Prepared and planted to beets they give a rental value of $5 an acre, or a selling value of $75. Much of this stump land can be bought for $5 per acre.

From the standpoint of the investor financing a sugar plant in northern Wisconsin is quite similar to that in our arid States. Reclaiming arid lands requires considerable expense in building irrigating ditches. In addition it costs about $10 an acre annually to water the land. In Wisconsin these stump lands can be bought for a small expenditure per acre. Instead of investing money in irrigating ditches it must be applied to eradicating the stumps. Nature is bountiful in her supply of rain. This eliminates the cost of watering the land. In either case the low cost of lands makes it possible, with a small additional capitalization, for the corporation to acquire a large body of land.

Twenty years hence I look to see productive beet fields in that part of northern Wisconsin which is now a wilderness of stumps. After them will naturally follow all the other crops adapted to its soil. Through these will be brought industrial production, with many of these crops supplying the crude materials: Stock breeding, the dairy, the fattening pens, the canning factory, the creamery, the flour mill, the sugar factory. Each new factory installed under the present policy of establishing sugar factories will serve as a developing influence in its territory. Beet production will extend each year to new localities.

During 1904 there were a number of places in Wisconsin where the installation of the beet-sugar factories was under consideration. I will mention the leading places and some of the conditions and circumstances operating to arouse public interest:

BURLINGTON.—From time to time there has been more or less activity at Burlington touching the installation of the sugar industry at that point. Under the stimulus of overtures made by Michigan interests, looking to the establishment of a factory here, there was considerable agitation of the question this year. Desiring to procure as definite information as possible concerning the interest at this place, I wrote Mr. John Spieker, requesting a report on the situation.

He does not appear to hold out much encouragement regarding the prospects of a sugar factory in the near future. His communication, however, reveals some of the things often mentioned by me with which the sugar industry has to contend. He appears to claim that the creamery industry has gained so strong a foothold and absorbs so much attention as to make it difficult to propagate among the farmers an interest in beet growing. In stating this difficulty he has given the strongest argument for the installation of a sugar factory, as the refuse of the beet fields—composed of the poor beets and beet tops—with the pulp from the sugar factory would be the great bulwark of

the creamery industry. This communication also reveals the natural conservatism of farmers when approached on this subject. The report is as follows:

BURLINGTON, WIS., *January 7, 1905.*

DEAR SIR: In reply to your request, I must say that there has been no sugar-beet seed planted this year in my neighborhood. However, I have made some experiments with seed sent to me by the Wisconsin Experiment Station. I also planted 2½ acres in sugar beets for the Menomonee Falls sugar factory, with results not very encouraging. The season was so dry and hot that the beets could not grow; the crop was very small, only 10 tons from the plot, but the per cent of sugar content was high—averaging over 14 per cent. The name of the seed was Kleinwanzlebener. The seed I got from the State Experiment Station was of the same variety. I planted this seed about eight years ago, and the result of the test was also over 14 per cent.

The sugar industry got a bad blow the year the farmers raised about three carloads of beets for the Menomonee Falls factory by being wholly unprofitable. Farmers did not understand the crop cultivation and did not take proper care of same, and the labor question was a serious one. Of late years farmers have had hard work to hire hands to do the necessary farm work which they are accustomed to do with the aid of machinery, to say nothing about the hand work they must perform in sugar-beet fields. Aside from that, the beets were raised too far from a railroad station; hence the interest was killed right there.

Before we ever thought of the Menominee Falls factory a brewer of Milwaukee wanted to build a sugar factory at Burlington; bought a farm and promised to build. The citizens of Burlington gave him all the encouragement they could; they collected money and sent a committee with this capitalist to look into the Nebraska factories. It was favorably impressed, but the whole plan fell through because the farmers would not sign enough acreage. The capitalist wanted 2,500 acres pledged for three years. The farmers around this town were not pressed hard enough to take it, and the beet-sugar interest is a thing of the past.

The capital went back to its old stand-by, brewing beer, and the farmers kept on milking cows, and will do so until they get hold of something that pays better. We now have a milk-condensing factory at Burlington that receives about 50,000 pounds of milk daily in winter, and I believe it would be a hard matter to turn the farmers to any other course, as this is a home enterprise, and we are in a section of country with the right kind of grass.

Yours, truly, JOHN SPIEKER.

CALEDONIA.—The business men of Caledonia and the farmers of the vicinity are taking an active part in promoting an interest in the beet-sugar industry at this point. Recent press dispatches, under date of December, announced that plans have been matured for building a plant costing $600,000. This naturally suggests a plant with a daily capacity for slicing 600 tons of beets. The promoters of this enterprise are Louis Volters and Joseph Stehlik.

CLINTON.—At Clinton several public meetings were held and the sugar industry discussed. At these meetings parties from Janesville outlined the requisites necessary for establishing a sugar factory.

EAU CLAIRE.—At this place also considerable interest has been aroused. It is only 8 miles distant from Chippewa Falls, which is already operating a factory. Consideration of the question at Eau

There seems to be a very great variation in the sugar content, even with beets grown on apparently the same soil and under the same conditions. The factory reports that the beets for 1904 contained 14.45 per cent of sugar as against 15.6 per cent in 1903.

There has been some talk of a factory at this place; but I do not think there is much prospect for one for some years, as the one at Menominee can, and will be glad to, use all the beets grown in this section for a long time to come, as their season's run has been very short.

I am not in position to give you names and addresses of growers, as I am personally acquainted with but few of them. Most of these speak favorably of the growing of beets. As to my own opinion on the matter, if you care for it, I will say that I believe it a fine thing for the growers and the country generally.

Yours truly,

SILAS S. SMITH.

MADISON.—Late in the season Madison took up actively the consideration of establishing the beet-sugar industry. Beets have been grown here for the factory at Janesville and were pronounced by the management of that institution of excellent quality.

Madison is situated between two beautiful lakes. It is surrounded by an old substantial farming community, accustomed to the better modes of farming. It is the location of the State experiment station and the home of Prof. W. A. Henry, its director. He has been very active in experimenting and studying the interests of the beet-sugar industry in the State for a number of years. He took an active part in considering the installation of this factory at Madison. With reference to this enterprise the American Sugar Industry and the Beet Sugar Gazette has the following to say under date of December 20, 1904:

Work on the new 600-ton beet-sugar factory will be commenced as soon as the weather will permit excavation. Contracting for acreage is in progress and farmers are signing rapidly upon the following basis: The minimum price of beets is to be $4.50 per ton. For all beets testing over 14 per cent the company will pay 25 cents more per ton. The company will also pay 25 cents per ton in November to farmers holding their beets and not anxious for early shipments. The company will furnish expert advice to the farmers in caring for their crops, and all testing and taring will be done by men appointed by Prof. W. A. Henry, of the University of Wisconsin. Outside shippers will be granted a rate of 25 cents per ton for a distance of 50 miles, and all car shipments will be weighed by the Western Railway Weighing Association.

With reference to the organization and installation of this plant, the Eau Claire Leader, under date of December 3, reprints from the Madison State Journal the following statement:

A sugar-beet factory for Madison costing nearly three-quarters of a million is one of the immediate coming additions to industrial Madison. Articles of incorporation with a capital of $700,000 were filed in the office of the secretary of state to-day for the Dane County Sugar Refining Company. Theodore Hapke, of Chicago, one of the principal owners of the factory recently opened at Janesville, and United States District Attorney William G. Wheeler, of Janesville, are in the city in its interest to-day and brought the articles with them. The factory will be a duplicate of the one at Janesville and will probably be built on the east side of the city in the town of Burke. It will have a maximum capacity of 800 tons—that is, it will be able to

grind that many tons of beets every twenty-four hours. The incorporators whose names are attached to the articles are C. S. Jackman, Arthur P. Burnham, and W. G. Wheeler, of Janesville, but the principal owners of the business will be James Davidson, of West Bay City, Mich., and Mr. Hapke, chief owners of the Janesville plant.

Mr. Hapke will open an office in the city immediately to push the new enterprise and will begin contracts with the farmers at once to buy their beets. He asks no bonus of the city of Madison or any other parties, but wants their moral support and encouragement, which he feels confident of getting. The plant will occupy a large space of ground, as such plants do, and will have a pulp-drying factory also. He says Dane County soil is admirably adapted to the raising of beets and that many Dane County farmers who raised beets for him this summer for the Janesville factory raised as much as 20 tons to an acre. They are paying at Janesville $4.50 a ton for beets off the wagon. The supply of sugar, says Mr. Hapke, is not keeping up with the constantly increasing demand, and he predicts a prosperous future for the sugar-beet business.

To which, by way of comment, the editor of the Leader adds:

The business men of Eau Claire city and the farmers of Eau Claire County should bear in mind that a sugar factory can be had here just as soon as the necessary acreage is subscribed. Let this not be forgotten or put aside. With a very little exertion we can have a plant costing $750,000 and employing 500 hands.

MANITOWOC.—The Milwaukee News prints a report from Manitowoc, dated December 13, which reads as follows:

At a meeting called to interest farmers of the county in sugar-beet raising at Frances Creek, 70 tillers of the soil discussed the subject in all details yesterday, and it is probable that a beet-sugar factory will be located here. C. A. Watrous, of the Caledonia Beet Sugar Company, addressed the meeting.

PRAIRIE DU CHIEN.—For some time the business interests of Prairie Du Chien have been actively considering the proposition of establishing a sugar factory. Beets have not been grown around this locality extensively except in an experimental way. Mayor Mortimer and others of the town have been actively negotiating with the management of the Janesville factory with a view to securing a factory at this place. It appears that a proposition was made to Prairie Du Chien interests that a factory of 800 tons capacity would be built at this place to operate in 1905, provided contracts for 5,000 acres of beets are secured. In order to defray the expenses of securing this acreage the city donated $2,500 from its treasury. With reference to this project, the American Sugar Industry and Beet Sugar Gazette quotes Mr. E. C. Amon, who is secretary of the progressive association and cashier of the Crawford County Bank of Prairie Du Chien, as follows:

We have made arrangements with Mr. Theodore Hapke, of Janesville, to locate a sugar factory here this spring. We are to secure an acreage of 5,000, and have men out who are working among farmers for a 3-year contract. We will have the necessary acreage by March 1. Farmers are very enthusiastic over the prospect of a sugar factory here.

RACINE.—During the past year there has been considerable discussion on the subject of establishing a beet-sugar factory at Racine.

This probably grows out of the agitation that has taken place at Caledonia and Mount Pleasant near this city. It appears that the interest aroused in this instance is coming from the farmers themselves, headed by Mr. Alois Volter, who has been connected with sugar-beet growing in Michigan and Wisconsin for some time, and Mr. Joseph Shalik, editor of the Slavie, the leading Bohemian paper of the Northwest. It is proposed that the farmers in these localities absorb about $200,000 worth of stock.

Some consideration has been given to the location of the factory at Caledonia, and also to establishing it at Racine, which is a manufacturing point of some note. Several meetings have been held at Racine and by the farmers at Caledonia. It appears that public interest aroused in this place may eventually result in the establishment of a factory.

WATERTOWN.—For some time the farming district surrounding Watertown has been growing sugar beets for the factory at Menomonee Falls. It is one of the original sites selected by the Wisconsin Sugar Company as available for establishing a factory. Railroad interests particularly are urging this place as a proper location.

SPARTA.—Under date of December 20, in the American Sugar Industry and Beet Sugar Gazette, of Chicago, occurs the following with reference to Sparta's interest in the beet-sugar industry:

Messrs. G. W. Bartlett and Lew Roberts who, with William Van Antwerp, came here from Sparta to interview the Janesville Beet Sugar Company with regard to putting up a factory at Sparta returned with a very favorable report and the assurance that if the citizens of Sparta take hold of the matter as they should a factory can be erected inside of a year. If a beet-sugar plant is put in at Sparta, it will probably be a duplicate of the one at Janesville. The representatives of the Janesville company will visit Sparta in the course of a week to consult with the business men and farmers in regard to the matter, and if satisfactory terms can be made the plant will no doubt be installed next year.

MENOMONIE.—Considerable interest has been aroused at this place touching the building of a sugar factory. This is in Dunn County, a little west of Chippewa Falls and Eau Claire. It has grown beets more or less for the factory at Menomonee Falls in past years. The Menomonie Times, with reference to conditions and the practicability of establishing a sugar factory at this place, wrote Prof. W. A. Henry, director of the State Experiment Station at Madison. Professor Henry has pursued a constant study and investigation of soil conditions, crop productions, markets, and the development of the agricultural resources of the State generally. His reply is very suggestive and to the point. Since Professor Henry is the highest authority in the State on all subjects touching its agriculture, I reproduce a portion of this letter which appeared in the Eau Claire Leader, December 24, 1904:

Replying to your request of December 17, I will say that in my talk before the people assembled in the Congregational Church in your city, which talk was purely an accident, I told them among other things that if any State east of the Rocky

Mountains could successfully support beet-sugar factories it was Wisconsin. I told them further that we now had three factories in successful operation in Wisconsin, the oldest one at Menomonee Falls close to Milwaukee, and two factories running this year for the first time, one at Janesville and one at Chippewa Falls.

A representative of the Chippewa Falls factory, a Mr. Postel, has recently been to your city soliciting beet acreage. I wish to say that I have known Mr. Postel for some time, and I am also acquainted with Mr. Wagner, manager of the Menomonee Falls and Chippewa Falls beet-sugar factories. Both these gentlemen are, so far as I am aware, reliable and have always carried out their contracts and promises in regard to beet factories and the purchase of beets.

I told your people in my little talk that it was not time yet for a sugar factory to be built at Menomonie; that a factory costs from $400,000 to $800,000, and that we could not expect capitalists to invest that large sum of money until they were sure that the farmers would grow beets enough to properly and profitably support such a mammoth institution. Farmers can not prudently contract to grow beets for three to five years until they know whether they want to grow them at all or not, and whether there is a profit in growing them. No factory can afford to locate at a given point until it can have at least 8,000 acres of beets contracted for five years in advance.

The farmers of Dunn County should next season grow not less than 1,500 acres of beets. The Chippewa Falls factory will furnish the seed, send men to explain the work, and give all advice and counsel necessary to properly carry on the work. The next fall these beets can all be shipped to Chippewa Falls and there be made into sugar. The price of beets runs from $4.50 to $5.50 per ton. The yield runs from 8 to 20 tons per acre, generally 12 to 15 under favorable conditions.

Now, if you can grow 1,500 acres of beets at Menomonie the coming season, and can get $60 to $70 per acre for the crop, it will bring a whole lot of money to your community.

If the people around Menomonie will grow 1,500 acres of beets next year and 2,000 or 3,000 the following year, I am sure capitalists will be willing to come to your town the third year and put up a factory, provided at that time the farmers are still satisfied with the business.

Let me say in conclusion that the beet-sugar industry offers a fine opportunity for Dunn County. You can grow eight or ten thousand acres of beets in your county and still raise as much clover, corn, and other crops as now. I would rather see Dunn County go into the beet growing than into tobacco production. Every dollar of beet money will go to the farmer, to the boys and girls who help weed, to the railroad companies for freight; and thus the money will be well distributed. Your business men should take this matter up and push it vigorously, as it means a whole lot of money for Menomonie.

Beets should be grown in rotation and never twice on the same land until other crops have intervened. Wisconsin's sugar bill is over $6,000,000 a year, or $20,000 a day. Why not produce the sugar and save that vast sum to the State instead of sending it to Germany or Cuba? I sincerely hope your people will push this matter.

WYOMING.

There are three or four places in Wyoming actively investigating the establishment of the beet-sugar industry. Generally its conditions are quite similar to those of Montana, Idaho, and Colorado. These have been thoroughly outlined in the discussions of the agricultural conditions of those States. The consideration of this subject for this

State must necessarily be confined to a few points, though there are very many places adapted to this industry when the State shall become more densely populated, and when railroads and other developing agencies shall make all parts more accessible.

Like other mountain States, its energies have been directed largely to its mining interests. Its agricultural development is of later date, and promises much under the influence of irrigation. Extensive agriculture will be confined necessarily to districts accessible to irrigating facilities.

The principal streams affording water for irrigation are: The Green River and its tributaries, draining to considerable extent the southern and eastern half of the Yellowstone Park, flowing south through Sweet Water County; the Big Horn and its tributaries, which rises in the central part of the State and flows north through Fremont and Big Horn counties, covering a large part of the northwestern corner of the State; the Powder and Belle Fourche, in the northeastern part, flowing north; the first watering Johnson and Sheridan and the second Cook and Weston counties; the North Platte and its tributaries, in the southeastern corner of the State, flowing east, covering Carbon and parts of Matrona, Converse, Albany, and Laramie counties.

The principal sections of the State now under consideration are naturally those having already established irrigation systems and which are better developed in agricultural production, viz, the southeastern part, watered by the North Platte and its tributaries, and the northwestern part, watered by the Big Horn and its tributaries.

The State has some peculiar advantages of its own applicable to the beet-sugar industry. It has extensive coal fields covering a large part of the State. The quality is of the best lignite variety. Mines are being rapidly developed. This State is fast demonstrating its ability to furnish its own people and those of surrounding States with a cheap fuel of good quality.

In addition to this, in several sections of the State large oil fields have been discovered. This petroleum product has proven itself a very extensive fuel resource. The coal, petroleum, and mineral deposits are stimulating increased transportation facilities and general industrial development.

The State possesses those admirable qualities of climate especially favorable to root growing, and especially many days of sunshine for the elaboration of sugar in the beets. At present Wyoming is one of the greatest grazing States in the Union. Stock interests would be enhanced especially by the installation of the beet-sugar industry.

FORT LARAMIE.—Various interests have concerned themselves from time to time in that section in Laramie County near Fort Laramie. This is the junction of the Laramie River and the North Platte. Irrigation has developed to a considerable extent in that locality; it has

railroad facilities, and is especially promising for the installation of the beet-sugar industry. No doubt a factory will be located somewhere in Laramie County in the near future.

LOVELL AND GARLAND.—There is a large colony of Mormons settled in what is known as the Big Horn Basin. Stimulated by the advantages of this settlement and the general adaptability of the soil and climate, the district has been under investigation for some time. The Utah Sugar Company, in which the leaders of the Mormon Church are interested, have been giving considerable attention to the claims of this section in Wyoming.

Byron Session, president of the "Mormon stake" and the principal officer of his sect in that locality, announced that the Mormon interests in sugar production in Utah will build a factory of 800 tons daily capacity in this section, to be in operation in 1905.

A test of beets grown here by the Utah Sugar Company showed an average of 14 per cent sugar, and proved that their maturity is much earlier than in the State of Utah. The location of the factory is to be at Lovell or Garland. Whichever place is selected, it is quite probable that the other will follow with a factory some time in the near future.

Of this project, under date of October 9, the Salt Lake City (Utah) Herald has the following to say:

> Last summer representatives of the Utah Sugar Company visited Big Horn County in the interest of this enterprise. They made an analysis of the soil, thorough tests of the beets grown in that locality, and all other investigations deemed necessary. As the result of this, it is announced unqualifiedly that next spring work will be started on a sugar factory at Lovell that will cost $800,000.

SHERIDAN.—The location of a factory at Sheridan has been more or less under consideration for the past three or four years. The soil has been tested, beets have been grown which have proven of fine quality, and natural conditions seem very favorable to such an enterprise.

During this summer parties interested in sugar production in northern Colorado, around Longmont, Loveland, and Fort Collins, have been making special investigations of this place. F. M. Shaw, a special promoter representing the interests of the Fort Collins factory, and Mr. Patterson, of Loveland, investigated this field in the latter part of the fall. In January Mr. Patterson, assisted by Mr. Loukes, cashier of the First National Bank of Sheridan, and Mr. Masters, one of the leading ranchmen and cattlemen of that section, were actively promoting the establishment of a factory at this place. The two gentlemen in interest at Sheridan visited the factory and beet fields at Fort Collins and were quite enthusiastic in the movement. Prospects for a factory at this point hinge largely upon the disposition of the farmers to grow the beets. Indications point to a factory at Sheridan in the near future.

RECAPITULATION OF NEW FACTORY PROJECTS.

Locations where arrangements are complete for the establishment of factories in 1905 (12 in number), with the capacities of the plants in tons of beets daily, are as follows:

CALIFORNIA: Colusa, 400 tons.
COLORADO: Lamar, 500 tons; Brush, 600 tons; Holly, 600 tons.
IOWA: Davenport, 500 tons.
ILLINOIS: Riverdale, 350 tons.
MONTANA: Billings, 600 tons.
UTAH: Gunnison, 600 tons; Lewiston, 600 tons.
WASHINGTON: North Yakima, 600 tons.
WISCONSIN: Madison, 600 tons.
MICHIGAN: Blissfield, 600 tons.

The other points at which factories will quite probably be built in the near future (32 in number) are as follows:

COLORADO: Brush, Julesburg, Craig, Sterling.
IDAHO: Caldwell.
IOWA: Iowa City, Des Moines, Marshalltown.
MICHIGAN: Sault Ste. Marie.
MONTANA: Conrad.
KANSAS: St. Francis, Arkansas City, Emporia, Lakin, Deerfield, Garden City.
NEBRASKA: North Platte, McCook, Culbertson.
WISCONSIN: Burlington, Caledonia, Eau Claire, Green Bay, Manitowoc, Prairie du Chien, Racine, Watertown, Sparta, Menomonie.
WYOMING: Fort Laramie, Lovell, Garland, Sheridan.

CLIMATIC CONDITIONS AND FARM AND FACTORY RESULTS FOR 1904.

FAVORABLE CLIMATIC CONDITIONS.

Generally speaking, the season has been quite favorable throughout the beet-growing districts. In many respects the year seems to have been a turning point for the industry. As a rule, factories after closing the campaign of 1903 were unable to secure sufficient acreage. The general favorableness of the season of 1904, coupled with the better adaptability of the growers to beet production, has brought about much better satisfaction among the farmers, greatly improving the prospects for the next season. Labor for the fields was much more easily secured than usual. While the acreage for each factory, as a rule, was less, the average yield of beets was much better and the percentage of sugar and purity of the beets was remarkably high.

Throughout the beet-growing districts conditions were not so favorable for other crops. This has produced a general feeling favorable to beet growing. Conditions, methods, and results of the beet crops are now so generally appreciated that farmers are much better qualified

to make deductions. Viewing the country as a whole, the beet-sugar industry may be generally considered progressive. This is more particularly due to the following reasons:

BETTER METHODS AND IMPROVED FACILITIES.

There is a very marked improvement of methods throughout the country. Factories are more insistent on methodical supervision of the beet growing—selection of land, distribution of better seed, and better cultivation. The farmers are giving more attention to the growing of beet crops, the preparation of the seed bed, cultivation, doing things at the proper times, and are getting much better results.

Factories through the country during the season gave considerable attention to improvements in methods and facilities. Especially noteworthy is the introduction of processes for more complete extraction of the sugar in the molasses. This is accomplished usually by the processes known as "osmose" and "steffin." Most of the factories use the osmose process for the more nearly complete extraction of sugar from the molasses. In order to accomplish this work to a greater extent many have installed the steffin process.

In addition to improvement of the factories themselves, the year has been marked by a vast improvement in the installation of switches, country dumps, branch railroads, trolley lines, irrigation, better wagon roads, more satisfactory contracts with the farmers, and better relations between the factories and the beet growers.

The improvement is also noticeable on the farms around factories where beet growing has obtained for a considerable time. Soil improvement is especially noticeable. As a rule, in every factory district the average yield has been higher than that of any other year since the beginning of the industry.

To the same extent is noticeable the improvement of the auxiliary features of the beet-sugar industry. Throughout the length and breadth of the beet-sugar belt, especially in the beet-sugar factory districts, there is a very rapid increase in cattle feeding, breeding, and creamery production.

The beet-sugar districts have greatly improved and increased general agricultural resources. Rotation is more generally practiced, and fertilization of the soil is becoming the rule. These districts are permanently establishing the crops to be grown in rotation with sugar beets.

At the close of no other year has there been so many different enterprises for the establishment of additional factories on foot. Indications point at this time to a large number being installed in the country during the next two years.

Along with the general improvement of methods and results on the farm is the introduction of improved implements. It may be said that

there is a general tendency to do away with much of the hand labor incident to sugar-beet growing. At present a large part of the labor of growing this crop is in the hand work required in bunching, thinning, weeding, and harvesting the crop. From many places are reported special implements introduced for the first time this season, designed for bunching the beets. These are generally denominated "blockers." At present this is accomplished with the hoe in the hands of a laborer passing down the row, clipping out the beets from spaces in the row, leaving bunches 7 to 10 inches apart. The purpose of the "blocker" is to do this work. It is an implement working automatically, and pulled by a horse, and it bunches or "blocks" two rows at once.

At present harvesting the beets is accomplished by the aid of simple plow harvesters, which cut off the tap roots of the beets, loosening and to an extent elevating them. Following this comes the hand laborer, removing the crowns with a knife and piling the beets ready for loading into wagons. The "Yankee" is diligently trying to invent a harvester, one that will loosen, elevate, top, cleanse from dirt, and load the beets into wagons. Quite a number of these were tried for the first time this year with considerably more success than in any previous year. Enough has been demonstrated by these different harvesters to indicate that we are eventually to have a harvester which will accomplish much of the work now done by hand.

SUGAR BEETS AND HAIL STORMS.

In many places in the Mississippi Valley and the intermountain States the hailstorm is the terror of the farmer. As a rule such storms do not cover large areas. Oftentimes, however, they almost totally destroy the crops on the areas covered, bringing loss and ruin in their wake. They often beat the vegetation in the fields into a bruised and shapeless mass. Few crops can recuperate under such circumstances, and certainly none so quickly or completely as sugar beets. I have seen the same field of beets twice in one year denuded of every vestige of leaves, with the beet crowns bruised and battered up, recover and produce a tonnage averaging with beets in a near-by locality not disturbed by hail.

Sugar beets carry their own insurance against a hailstorm. This is a fact well worthy of consideration by farmers planting crops in beet-growing sections, and one which is now thoroughly appreciated by such farmers. The views presented in Plates I and II illustrate the hardiness of sugar beets under such conditions when well started.

Plate I represents a field of beets doubly afflicted on June 27, 1902, the picture (fig. 1) being taken the next day. The field belongs to Jessa Forbes, near Kersey, Colo. First, a terrific hailstorm on this date destroyed the leaves of the beets. Then, following the hail, came

excessive rains which flooded the field, causing the beets to fall over on their sides apparently completely washed out of the ground.

Figure 2 shows the same field of beets as it appeared on July 23 following. As soon as the owner could get on his land after the hail and flood, the beets were given a deep cultivation, and were straightened up with hand and hoe. As shown in figure 2 the beets have fully recovered and show a healthful growth with abundant foliage only twenty-six days after the storm.

Figure 3 shows a view of the same field taken September 5, just prior to the harvest. These beets were a little bent and unshapely, but they yielded 16 tons per acre, with high sugar content and purity. What other crop could have made such a showing?

Plate II represents the field of R. F. Alden hailed out June 27, the view (fig. 1) being taken June 28.

Figure 2 represents specimens of beets taken from the field six days after, showing the growth of foliage in that short period.

Figure 3 represents the same field as it appeared September 5, just prior to the harvest. This field yielded 24 tons per acre, with high sugar content and purity.

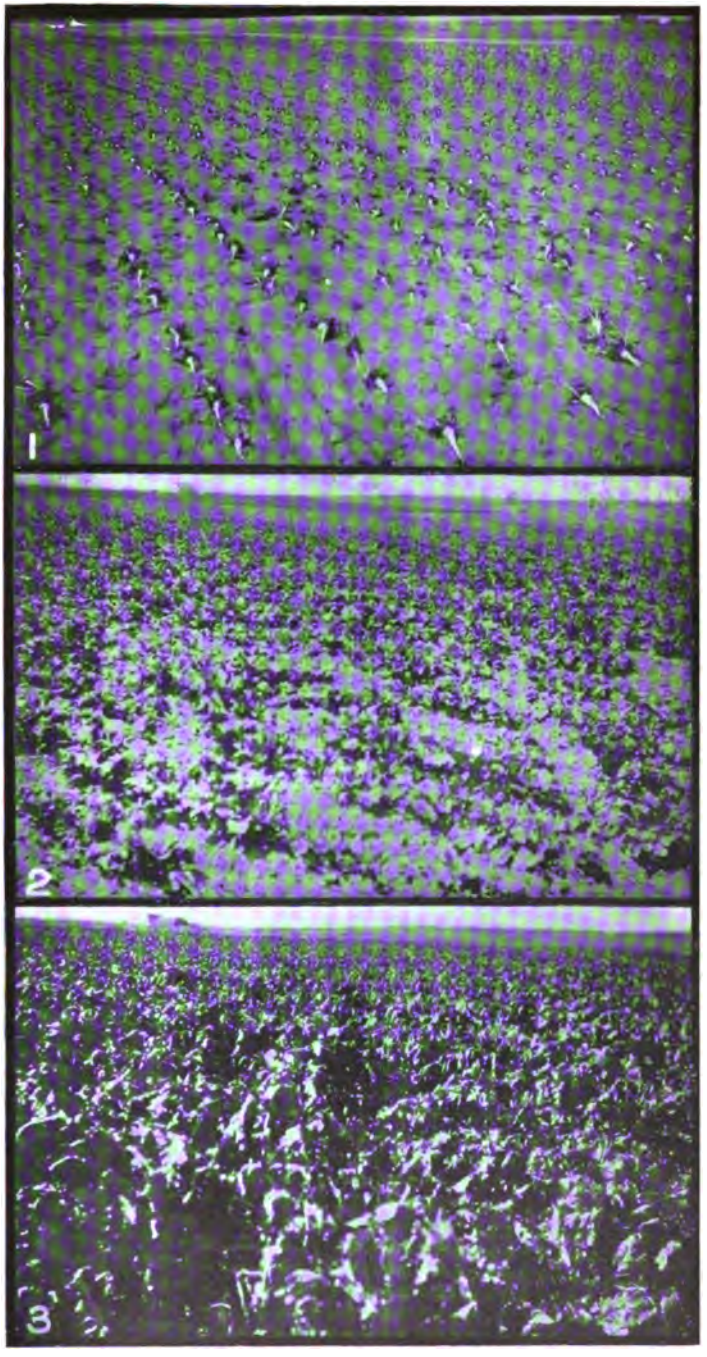
EXPERIMENTS ALONG NEW LINES.

During the season there has been a great deal of experimentation in beet growing in the fields. The Bureau of Plant Industry of the Department of Agriculture is endeavoring to produce a race of beets having seed balls containing but a single germ (see p. 161). At the present time the seed commonly used has from 1 to 7 germs in each seed ball, many of them producing that many plants. It is evident that this very materially increases the difficulties and expense of thinning. By the single-germ seed it is expected to do away with a large part of this work and expense.

The Bureau of Plant Industry is also endeavoring to establish the production of home-grown seed (see p. 177). For this purpose it has been furnishing different factories and growers in the country high-quality seed. It hopes to develop seed of higher germinating power, which will produce beets of higher sugar content and purity.

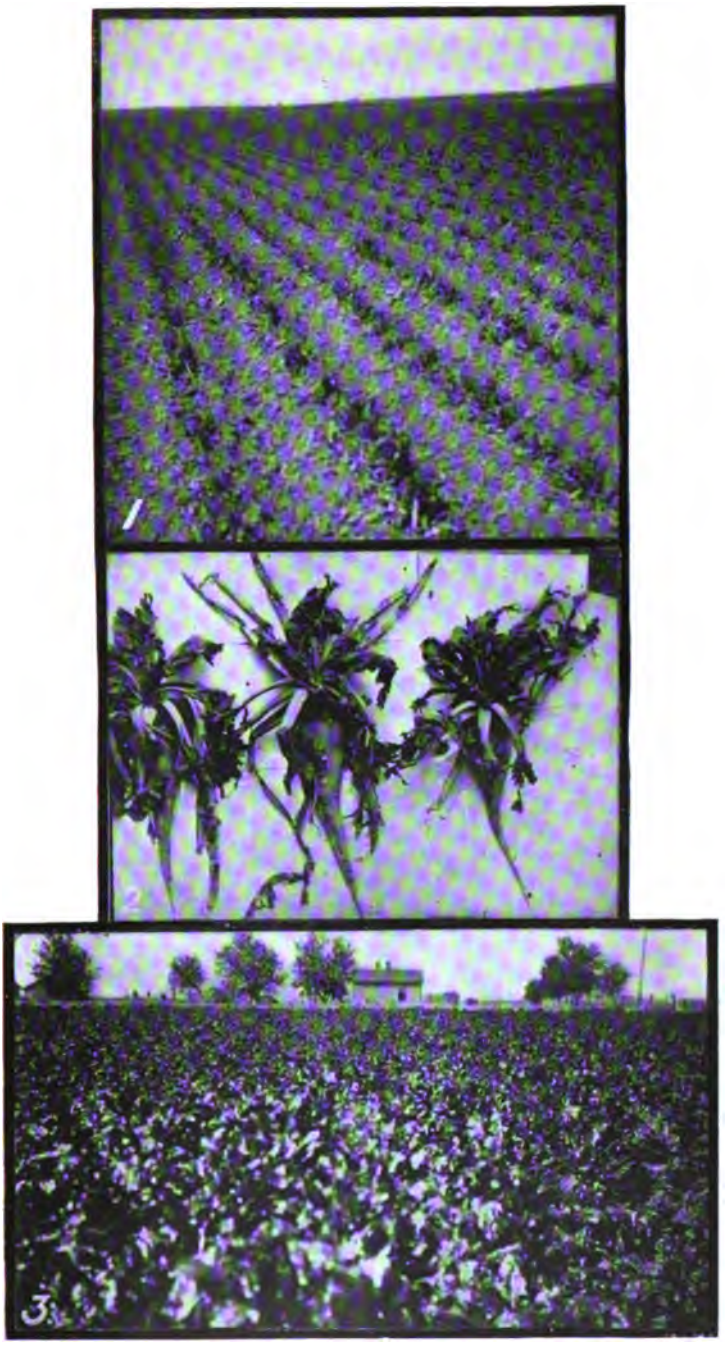
The Bureau is also experimenting to discover the elements of fertility required in the different sections where sugar beets are grown (see p. 167). For this purpose it is conducting fertilizer experiments. Many of the factories throughout the country cooperated with the Bureau in promoting this experimental work. Results of much of this work have already indicated a great field for future improvement. These experiments will be continued and extended.

The results of the year demonstrate that the beet crop is very remunerative, compared with others. Our farmers, with their better understanding of the crop and methods of production, are considerably



EFFECTS OF HAIL AND RAIN ON FIELD OF BEETS.

1, Beets hailed and flooded out June 27; 2, same field 26 days later; 3, same field September 5.



EFFECTS OF HAIL STORM ON FIELD OF BEETS.

1, Field of beets hailed June 27; 2, beets from same field 6 days later, showing new growth of leaves; 3, same field September 5.

reducing the cost of the work. Taking the average yield the country over, coupled with the average price, there is no other field crop that can make as favorable a showing. The average gross receipts per acre for the beet crop during the year were, in round numbers, about $50 per acre. The average net returns, after deducting the cost of production, were from $15 to $20. We have a great many instances of farmers receiving $100 to $125 per acre.

There are many things which denote the general beneficial effects of the beet-sugar industry. These are especially noticeable in States where the industry has been established to a considerable extent. In Utah, Colorado, and Wisconsin the press and public are thoroughly convinced of its usefulness. Enough has already been developed to indicate that it may be the developing industry of Idaho, Wyoming, Montana, and many other places whose conditions and resources agriculturally are in their infancy. The status of the industry in Colorado furnishes the greatest object lesson of all.

In the following pages I give a review of the status of the industry in the several States in which it has been established, and an account of the operations of the several factories and their results for the year 1904:

CALIFORNIA.

It may be stated that prevalent conditions in California were generally quite favorable during the year. The industry has been gradually growing up to the boundary lines set for it some time ago. The factories in the State, while not numerous, are unusually large. This practically has the same effect as the building of a larger number. It has taken several years for some of these concerns to increase beet growing in their districts to the point where the supply of beets equals the demand.

The operations of the year developed nothing of special importance that is new. Each year adds to the irrigation facilities of the beet-growing districts. This applies to irrigation from running streams, from storage reservoirs, and from artesian wells. Probably the most noticeable improvement in connection with the industry is the rapidly growing stock-feeding interest induced by the sugar industry. In general the operations of the five factories which were running in California in 1904 may be summarized as follows:

The average acreage of the factories in operation was 6,560 acres.

The average yield per acre was 12.01 tons.

The factories worked an average of 79,000 tons of beets.

They produced in sugar an average of 18,662,380 pounds, or 9,331.19 short tons, per factory.

The sugar content of the beets averaged 15.74 per cent; the purity, 81.13.

Altogether the factories paid to the farmers, in round numbers, $2,000,000 for beets.

Of the eight factories in this State three did not operate this year.

CROCKETT.—The factory at Crockett was a combined beet-sugar plant and Hawaiian sugar refinery. It has ceased the production of beet sugar and continues as a refinery.

WATSONVILLE.—The factory at Watsonville has been closed during three campaigns.

ALVARADO.—This factory was eighty-two days in operation during this campaign. The rainfall was irregular and scant during the winter preceding the season of 1904, very little falling in the months of January and February. This caused farmers to fear a shortage and impelled them to seed for grain or hay. In March there was too much rain, preventing field work. Precipitation occurred on twenty-six days in the month. Only 15 acres of beets were sowed previous to April 1. From April until August good growing weather prevailed, with July and August not too hot. In August, before the beets gave any outward signs of maturity, such as the yellowing of the lower leaves, the district had a comparatively heavy rain. This was followed by heavier and more copious rains during the last third of September. As a consequence, the beets continued to grow at the expense of both sugar and purity.

The beet crop is growing in favor with the farmers, as they now pay more attention to rotation and to cultivating their crops, thus getting more tons per acre. Beets were furnished the factory this year by 246 contracting farmers. The price paid for beets was $5 per ton.

Prospects for next year depend upon the rainfall during January, February, and March. If plenty of rain falls during this time, prospects are good for the planting of about 5,000 acres of beets next year.

The factory usually plants one-third each of the varieties of seed named below, with their sources of supply: Wohanka & Co., Prag. "Zuckerreichste;" W. Mette, Quedlinburg "Elite" Kleinwanzlebener; Kleinwanzlebener "Original."

The prevalent soil in the district is sandy loam, subject to overflow. All beets are grown without irrigation.

BETTERAVIA.—Conditions for beet growing were quite favorable in this vicinity during the season. Beets for this factory mature early, the sugar campaign usually beginning the first part of July. The beet crop generally was very satisfactory throughout all the districts furnishing it a supply. This year the factory began slicing beets July 10. The amount of beets worked was the largest in the history of the factory.

CHINO.—Weather conditions were quite favorable for beet growing in the early season. Spring rains were quite abundant. Beets were grown for this factory in some districts where planting can be done

as early as February. Considerable acreage was planted early, and in these fields thinning was in progress as early as April. Through this month rains were quite abundant. The stand of beets was good.

About 4,000 acres of beets were planted in the vicinity of the factory. Considerable acreage was planted in the vicinity of Anaheim and Orange and at other places some distance from the factory.

The company is experimenting in a new locality, near Thermal, where beets mature much earlier. If the beets prove of good quality, by planting sufficient acreage in this district the factory will be enabled to begin operations much earlier. This plant did not operate this season. The beets from this district, approximately 35,000 tons, were shipped to the plant at Oxnard, which belongs to the same company.

Los Alamitos.—The work of this factory has done much to revolutionize agricultural conditions in its vicinity. The farming area surrounding it was originally an immense sheep-grazing ranch. Seven years ago this factory was built. It started on its career reclaiming this wild expanse of grazing land. A large part of its beet-growing lands is now under irrigation, water being supplied from flowing wells. In the vicinity now are annually fed a large number of cattle and sheep for the Los Angeles market. The plant owns considerable acreage. It is also interested in the Bixby Land Company, which owns a large tract of land in this vicinity.

The waste molasses and pulp by-products are all utilized to the best advantage. The molasses is sold under contract to feeders, who mix it with their hay when it is stacked, where it is allowed to go through the sweating process and is afterwards fed. This seems to produce a very palatable and desirable feed.

The sugar company installed this season the osmose process for more complete extraction of sugar from the molasses. This will reduce this waste product to a small amount.

All crops in southern California during the latter part of the growing period were affected to a considerable extent by the hot dry weather. As most of the beet-growing plats of this district are irrigated, this drought did not affect the beet crop so much.

The general results of growing beets were satisfactory. Beets have always shown a very high quality here. During one week this season the beets received showed average sugar contents reaching almost to 19 per cent, with a purity over 83.

This district received a bountiful supply of winter rain, one downpour the latter part of December, 1904, amounting to 2.1 inches. Such a rain in the winter in this district means much for crops generally.

The farming district is using extensively for fertilizer, especially for fruit lands, the refuse lime cake produced by this factory.

OXNARD.—This factory had an unusually large supply of beets for this campaign. Many of these came from the Chino district.

As usual the sugar contents were very high, ranging from 16 to 17 per cent, while the coefficient of purity of beets averaged 85.

This factory has developed large feeding interests, the company being interested in a large ranch near-by on which it feeds several thousand head of cattle annually.

Owing to the hot, dry weather prevailing during the latter part of the growing season the average tonnage of beets was not up to standard; but this result was accompanied by a higher sugar content and purity, which offset to a considerable extent the lower tonnage.

The unfavorable season affected all crops, and comparatively the beet crop gave better results than the rest.

COLORADO.

Conditions throughout the State, both north and south, were exceptionally good during the past year. Farmers are demonstrating better adaptability to the work, and are producing more and better beets at less cost. There were some floods, insect attacks, and hail storms, with consequences somewhat local and not of general importance.

Indications point to considerable extension of the beet-sugar production in this State in the near future. At the present time the six northern plants in the State are associated together under one management. The same interests have organized the Great Western Sugar Company, with a capitalization of $20,000,000. This company proposes to put in several new plants in the State, three of which are already planned and settled for next year.

There has been a very remarkable growth of the stock-feeding interests of the State, and an especially noticeable and satisfactory increase in the use of pulp. All the factories in the State are now able to dispose of all the pulp at a good price. Several of them had to turn away large orders for this by-product. Appreciation of pulp feeding in Colorado has developed more quickly than in any other State manufacturing beet sugar.

It might be said that the industry itself has moved along more satisfactorily in this State than in any other. Conditions seem to be highly suitable to the industry wherever a factory has been built. The State is naturally proud of the industry, as there is every reason it should be.

As indicating the appreciation of the work done by the United States Department of Agriculture, I quote from an article in the Denver Post of January 1, 1905:

> Several years ago a man sat in his office in Denver and read a Government pamphlet on the beet-sugar industry. He had never been guilty of such a thing before. He never expected to be again. But he had already received several similar pamphlets, all about beet sugar, and he decided to wade through the subject and be

done with it. Instead, he waded through and began with it. The more he read the more he became interested. He sent back to Washington for more information. He got it—by the bookful. He went into a thorough personal investigation of the beet-sugar proposition. He was not afraid of a thing because it was new. All he cared about was whether it was a good business venture. He was a Westerner and the West takes chances and sees success a long way ahead. It is less hampered and broader visioned than the East. Therefore he invested in beet sugar.

That man was John F. Campion, the father of the beet-sugar industry of Colorado, that lusty infant that has shot up out of all proportion to the probabilities. Five years ago the first beet-sugar factory was built in Colorado. To-day in the production of sugar beets this State leads the country.

The following is a summary of the results for all the Colorado factories for 1904:

The average acreage of the factories was 4,939 acres.
The average yield per acre was 12.32 tons of beets.
The factories worked an average of 6,115 tons of beets.
They produced in sugar an average of 13,839,311 pounds or 6,919.65 short tons.
The sugar content of the beets averaged 15.64 per cent; the purity, 82.46.
The factories paid to the farmers for beets, approximately, $2,751,595.

EATON.—The contracted area for growing beets for this factory was somewhat less than formerly. However, the farmers have received more training, and with favorable conditions the beet crop has been considerably more satisfactory.

Irrigation was aided in the early season by more than usual rainfall. Better results in beet crops were secured than in any previous year. Prospects are good for next year.

The Eaton Sugar Company's campaign lasted sixty-one days, and was most satisfactory in every respect. A very favorable season, resulting in a heavy tonnage per acre, a growing familiarity with the crop and the dying out of prejudices, an increased confidence in the sugar company and its methods, and low prices for other farm products all cause farmers to view the beet crop with more favor than ever.

A machine to dig and elevate beets where they were to be topped from a platform by hand was tried the early part of the season, but was not considered a success.

About 200 farmers grew beets for the factory. A price of $5 per ton at the factory or loaded on cars was paid for beets. Prospects could not be better and the factory anticipates a large acreage for next year.

Nearly one-half of the seed planted is the Original Klein-wanzlebener. The best results in growing beets come from a clay loam which has been in alfalfa and is then put into beets, followed by potatoes, then beets, then alfalfa again.

FORT COLLINS.—This plant secured an acreage sufficient for a full supply of beets. The season opened very auspiciously, indicating a bountiful supply of beets.

Arrangements were made with the Department of Agriculture for

conducting experiments with soil fertilizers and in seed production to test conditions for producing home-grown seed, especially those with the single germ.

I have called attention in this report to the enormous increase of stock feeding in the State as a result of feeding by-products of the sugar factories. As an indication of the extent of this around this factory, I clip from the Beet Sugar Gazette, of January 5, 1905, in which a local paper of recent date is quoted as follows:

> The sugar factory has been compelled to turn away 35,000 head of sheep and 2,000 head of cattle, because this year's supply of pulp had all been contracted for and is now being fed on or near the factory grounds. There are now on pulp and alfalfa ration on the factory grounds, and in pens near by, 17,692 sheep and lambs and 3,322 head of cattle. Several shipments of sheep and cattle fattened on pulp and alfalfa have been made from the factory feeding pens in the last few days.

Near the close of the beet harvest the beet growers and their families were entertained by the factory management. This gave those interested in growing the beets for the factory an opportunity to witness the process of sugar manufacture, and, incidentally, to come into closer acquaintance with the factory management, all of which indicates better feeling between the two interests of the sugar industry.

GRAND JUNCTION.—This factory has been idle for two years. It secured acreage this season sufficient to furnish a full campaign. The beets were grown at various points tributary to the railroad delivering beets to Grand Junction. About 4,700 acres altogether were contracted.

The season was quite favorable. It is about three weeks earlier in the Grand River Valley than in any other part of the beet-growing area of Colorado.

While this factory has been operated through three campaigns before, many of its beets for this season were grown in practically new territory. The results have been very encouraging. It is safe to assume that the work of this year has placed this plant on a substantial basis among the successful plants of Colorado. Under the stimulus of its success this year it has arranged to double the capacity of the plant for next season. Work on this extension will begin immediately, in order to have it in readiness for the next campaign.

The factory is finding ready sale for its pulp, a large part of which is disposed of under contract to Goslim Brothers, extensive feeders. They are feeding at present 800 head of cattle and 15,000 head of sheep.

The campaign covered a period of one hundred and twenty days. The territory growing beets for the factory extends 104 miles east of Grand Junction, 17 miles west, and 98 miles south. The difference in elevation between the lowest and highest land which was in beets last season was about 1,500 feet. Consequently there is quite a variety

of climatic conditions. The past season, however, has been quite favorable.

In public favor the beet crop has made a tremendous leap this season. When the company was reorganized in 1903 beet growing was in great disfavor among the farmers of this section. For several months it required the unceasing and untiring efforts of a number of experienced men to secure contracts for 4,000 acres; whereas now, after a short period of solicitation by the field superintendents, they have secured contracts for 4,500 acres for next year (the contracts being written for one year only). This great change in sentiment is due largely to the irresistible determination of the new company. Much is also due to the services of an efficient corps of field superintendents. Generally the district possesses an abundance of water for irrigation. The fulfillment by the company of every representation and agreement has added much to the general revival of confidence among the farmers.

Contrary to expectations, experience this year has shown generally that the beet crop in this section does not do well following alfalfa. This is observed almost universally in this locality. The opposite is true on the eastern slope of Colorado and throughout Utah and Idaho. Experience demonstrates here also that beets can be "irrigated up" successfully. The district planted about 3,700 acres, and of these 2,600 acres were "irrigated up." There has been an impression among agriculturists that attempts to practice this on a large scale would be disastrous.

The factory had 1,000 contracting farmers this season. It paid $5 per ton for beets delivered at the factory or the nearest shipping point.

It used Rabbethge & Giesecke's Kleinwanzlabener seed, Dippe Brothers' Elite Kleinwanzlabener, and C. Braune's Kleinwanzlabener seed, about as much of the first-named as of the last two together.

It is difficult to describe the lands in the territory, as they are quite variable. There may be three or four different soils in one field. Roughly, they may be divided into three classes: The red light loam on the mesas, the gray adobe (with variations) in the middle belts, and the dark sandy loam in the bottom. The red light loam raises the most shapely beets, and, in point of sugar and purity, the richest. The gray adobe soil produces good tonnage, but a short ill-shaped beet. The bottom land gives the heaviest tonnage, usually with comparatively good sugar content and purity.

GREELEY.—The season from the start was quite favorable to beet growing. The contracted area for growing beets was not as large as that of last year. It was estimated that the supply for the factory would probably be larger, from the facts that the factory had exercised considerably more care in selecting its growers, and that these were better accustomed to beet growing.

A flood during the summer destroyed a few fields. It is demon-

strated that some lands not so favorable to potato production, which is the main crop of the district, are more productive in beet growing.

The quality of the beets for the season maintained the usual average, and the yield was larger than for any preceding year since the factory has been in existence.

The Greeley Sugar Company's campaign lasted seventy-five days, and was most satisfactory. About 412 farmers grew beets for the factory. The price for beets was $5 per ton at factory or loaded on cars.

LONGMONT.—The management of the sugar factory here gave more attention than usual to the selection of the beet growers, preferring those who by previous experience had demonstrated capabilities with this crop. The contracted area is not as large as last year, but the season proved very satisfactory and beet growing was quite successful. Prospects for next year are excellent.

LOVELAND.—This factory contracted for a full acreage this year. The plantings as a rule produced a good stand. The factory has now operated four years. Each of these has been quite satisfactory to all concerned. It has accomplished much in developing the facilities of the farming community in its vicinity. It has built and equipped a railroad 15 miles in length, especially devoted to its own uses. During the past season it extended this, built from it spurs and sidetracks, and also constructed several country dumps, where farmers can deliver their beets to the cars at short distances from their fields.

The farming area surrounding this district shared in the generally favorable climatic conditions which prevailed all through northern Colorado. Through rainfall and irrigation a bountiful supply of water was secured for all crops. The present year has been the best in beet cropping of any in the history of the factory.

ROCKYFORD.—The season has been quite favorable throughout the beet-growing territory of this plant during the year. Heavy rains fell in June, very much increasing the moisture supply, which is generally secured from irrigation. An unusually large crop of beets was grown and delivered to the factory. These were of good yield per acre and high quality. The crop was threatened in its earlier stages more or less by worms, but the injury proved of little importance, and did not result in any considerable damage.

Every sugar plant requires overhauling during the summer, if for no other purpose than to effect the repairs, which are considerable. At this time most factories also receive considerable improvement by the installation of new and better features. During the season this plant installed steam power to take the place of electric motors formerly in use.

The factory started up the latter part of September. On account of excessive rains interfering with the harvest, it closed down for a

few days, but resumed operations October 5. These rains occurring at the harvest had a tendency to materially lower the sugar contents of the beets for a couple of weeks.

SUGAR CITY.—Most of the land producing beets for this factory was plowed up in the fall. The plant owns about 12,000 acres; most of the beets are grown on its own land. These are leased to farmers for beet-growing purposes. Independent of this about 2,400 acres were contracted among 300 farmers. In all, 4,400 acres have been harvested. The factory paid $5 flat per ton for beets.

The plant has been experimenting with nitrate of soda as a fertilizer. Two thousand acres of the lands belonging to it were treated with this in preparing the land for the crop of 1904. In addition to the nitrate of soda, the company applied experimentally several different commercial fertilizers in order to demonstrate their comparative merits.

Stock feeding here has increased at a considerable rate, one company feeding 3,000 head of cattle. In this way the waste molasses and pulp by-products are disposed of.

The factory had a campaign of about one hundred and ten days. The past season was generally good for the beet crop in the locality. It grows in favor with farmers, especially those who have been successful. Encouraged by favorable results this year, they will grow beets more liberally next.

A new patented harvesting and topping machine was tried this season, but was not perfectly satisfactory in its work. The ground had to be in a particular condition; when the ground was a little too damp or too dry, it would not work satisfactorily; but, as all machinery of this kind is still in the experimental stage, the difficulties that have developed will probably be remedied. An implement of this kind is very much to be desired.

Irrigation is practiced generally in this semiarid region and, with sufficient water and the right kind of farming, beets are undoubtedly the most reliable and advantageous crop. The soil, quantity of water available for irrigation, method of cultivation, and particularly the energy and skill of the grower decide the issue of growing beets.

Land that has been in alfalfa for three or more years produces a satisfactory tonnage of beets. Fertilizers, outside of barnyard manure, are not resorted to, as a rule, in this part of the country except experimentally. Rotating with alfalfa will produce a satisfactory crop. The company had in one piece 481 acres of beets on land previously in alfalfa. This, the second year in beets, it yielded 10,100 tons, or an average of more than 20 tons to the acre.

WINDSOR.—The area planted to beets for this factory was somewhat less than that of last season; however, it produced quite a satisfactory

supply for the campaign, which lasted fifty-five days. About 110 farmers grew beets for the factory.

There were early indications of the destructive effects of the army worm, which, however, were finally confined to small spots, not spreading much, the damage being much less than anticipated.

Last year labor troubles, here and at other places in the northern part of the State, were more or less prominent. These have adjusted themselves. Growers and day laborers are more generally satisfied with conditions.

Stimulated by the output of waste molasses and pulp, feeders have shipped into this place for feeding purposes 15,000 lambs and 150 head of cattle.

The season was highly favorable and satisfactory. Higher tonnage than last year was produced. Farmers are more readily signing contracts and placing more reliance in the beet crop. Potatoes, one of the principal crops upon which the locality largely depends, sold at a very low price.

The district was again given an illustration of the performance of sugar beets, following a very severe hailstorm. On July 4 it destroyed almost everything growing in the fields. It was especially severe on potatoes and small grain, but its effects on the beet crop were hardly appreciable. Coupled with this is the fact that the farmers are becoming more adept at growing beets, producing cheaper, with better yield. The relation between factory and farmer is that of mutual friendship.

During the harvest a beet topper was tried at this place, but without satisfactory results.

The factory pays a flat rate of $5 a ton for beets, the same as most of the other factories in the northern part of the State.

The rotation practiced is, first, potatoes, then alfalfa, then sugar beets.

IDAHO.

The State now has three sugar factories, two of them operating for the first time this season; the other completed its second campaign. In view of the fact that all of these factories are operating under undeveloped conditions, with new surroundings and with considerable inexperienced help, results were very satisfactory. There are prospects for one or two other factories in the State in the near future.

In the small towns and agricultural district tributary to these factories a remarkable improvement is to be noted. They are especially stimulating settlements and building and improvements in towns in which they are located. Following the sugar factories and benefiting by the conditions developed, there is a general advance in agricultural products generally.

General results of the State during the year may be summarized as follows:

The average acreage of the factories was 2,566 acres.
The average yield per acre was 9.81 tons of beets.
The factories worked an average of 25,166 tons of beets.
They produced in sugar an average of 5,865,100 pounds, or 2,932.5 short tons.
The sugar in the beets averaged 14.88 per cent, and the purity 83.52.
This year the factories of Idaho paid the farmers for beets approximately $377,500.

BLACKFOOT.—The factory was operated here this year for the first time. It has accomplished much in stimulating business interests. It has decidedly encouraged improvements, building business blocks and residences, etc. The growing period for beets was generally favorable and, for the first crop, was very satisfactory. Considering the district, the growing beets received considerable rain, which aided materially in their growth and development. The season continued very satisfactory throughout, the yields of sugar beets being generally good. Results of this year have done much to encourage the new industry at this place. Contracts for growing beets for the factory next year are already arranged for nearly twice the acreage of this.

IDAHO FALLS.—The early season started very favorably, producing a good stand of healthy beets.

Mr. Thomas R. Cutler, general manager of the Utah Sugar Company, with two factories in Utah and two in Idaho, is the "father of the sugar industry" in those two States. He began his career as a sugar maker with the commencement of the Lehi factory, fourteen years ago. Due to him more than any other person is the development of this industry in Utah and its commencement in Idaho. As to conditions prevailing this year in these two States, he makes the following report:

SALT LAKE CITY, *January 14, 1905.*

DEAR SIR: In response to your communication addressed to our agriculturist of the Fremont County Sugar Company, Sugar City, Idaho, as well as the one written to our agriculturist of the Utah Sugar Company, we have gone over these questions thoroughly, and the result of our investigations is as follows:

The location of the Fremont County Sugar Company is at Sugar City, Idaho. The location of our Idaho Sugar Company is Idaho Falls, Idaho. The former factory was in operation this season sixty-two days; the latter, fifty-eight days.

In Idaho, for the first time in twenty-one years, a severe frost occurred in the early part of June, and wheat that was quite high was bitten very severely. Young beets that were being thinned were also touched, but in every case where such beets were even burned black and were left in the ground they grew out again and made excellent crops. Some of the farmers, however, got frightened and replanted, and these did not do as well as those who left their crops in the ground. The farmers are very much encouraged, therefore, with the beet crop and believe that it is superior to any other crop that they can raise, as it will stand the frost better than grain.

In Idaho, which is a newer country than Utah, conditions are somewhat reversed. Farms are of much larger size, because of the country being as yet thinly settled, ar d this necessitates the employment of an army of laborers.

Until the Idaho Sugar Company commenced operations foreign labor had not

been applied to any of the farming operations, but it became necessary, with the advent of the Idaho Sugar Company, to import Japanese laborers. In so doing it is an advantage to have large farms where gangs of Japs may be located permanently in the center to do the work; therefore the same conditions that apply to Utah do not obtain in Idaho at present, but as the State becomes more thickly populated farms will be cut up and the same conditions will ensue there as in Utah. The greatest consideration is the enormous quantity of available land and the supply of water, which is inexhaustible. There is perhaps no other State that is so rapidly coming to the front in agriculture as Idaho.

The number of contracting farmers was 350; the acres harvested, 4,650.

Fremont County Sugar Company has also built a slicing station 7 miles northwest of the main plant, where about half of the beets for that factory were sliced this season.

Yours, very truly, THOMAS R. CUTLER, *General Manager.*

SUGAR CITY.—The factory was operated at this place this year for the first time. Severe winds and heavy frosts injured crops generally in this section of the country. Beets demonstrated their superiority as a hardy crop by suffering the least damage of all. Generally speaking, this was small.

A special point of interest in connection with this plant was the wonderful revival of business activity it gave to the town, causing the building of residences, business blocks, new schoolhouses, opera houses, stores, etc.

The principal fertilizer for the beet crop is alfalfa plowed under with the green foliage during the summer season, the ground being planted to beets the following year. In this way it will enrich the land for a period of two or three years, and make it produce excellent crops if properly cared for. Then the crop may be changed to grain and alfalfa for a period of two years, and then prepared for beets again. In this way excellent results may be obtained. If alfalfa is plowed under, potatoes may be grown from the soil the same year. Barn-yard manure also gives excellent results when applied to the soil every other year; however, the alfalfa is the cheapest fertilizer. Clover is also very good for plowing under, and the same is true of peas. This question of fertilization is the most important one connected with raising sugar beets in the intermountain region, as the soils are not very rich in humus in their natural state. They can be fertilized with alfalfa as a green manure at an expense to the farmers of about $2 per acre, this being the cost of the seed necessary to plant an acre.

The Fremont County Sugar Company had 300 contracting farmers and 4,526 acres of beets were harvested.

MICHIGAN.

General climatic conditions in the State of Michigan, while a little changeable, were more favorable than usual. The spring was late, but finally opened up with fine weather, which continued during the early part of the growing season. There was plenty of rain, and it

was quite evenly distributed. Immediately prior to and during the ripening of the beets and the harvest the weather continued dry. The ripening and harvest season was, as a rule, ideal. Compared with other crops, the beet crop should be considered quite satisfactory.

The most noticeable feature in connection with the industry in this State is the fact that the farmers are becoming better satisfied and more interested in the sugar-beet crop. The acreage for the factories, as a rule, throughout the State was considerably less than might be desired. This was compensated for to some extent by the unusually high quality of the beets and the better yield of the acreage planted.

There is quite a growing tendency on the part of feeders in the State to increase the use of pulp. The waste molasses of this State, as a rule, is disposed of to a Bay City concern for the manufacture of alcohol, the product being of unusual quality.

One factory was removed from the State to Wisconsin, two have ceased building while still uncompleted, and three others were idle. Stimulated by the general good feeling of the farmers and the largely increased acreage now secured, it seems quite probable at this writing that the idle ones will be in operation next year.

The results for the 16 Michigan factories which were in operation may be summarized as follows:

The average acreage of the factories was 3,361 acres.
The average yield per acre was 8.06 tons of beets.
The factories operating worked an average of 27,089 tons of beets.
They produced in sugar an average of 6,491,551 pounds, or 3,245.8 short tons.
The sugar in beets averaged 15.13 per cent, and the purity 85.47.
All the factories of Michigan paid the farmers for beets approximately $2,383,854.

BAY CITY.—Considering the capacity and the length of time this factory has been operated, the acreage planted to beets was not very satisfactory. Farmers were discouraged to some extent here, as in other places in Michigan, on account of the two previous unfavorable seasons. Generally the weather conditions proved quite favorable throughout the year, and the yields were much better than for some years. The quality of the beets also was higher than usual.

There are two plants at Bay City belonging to this company, distinguished one from the other by the names "Bay City" and "Michigan." On account of the small acreage planted and the consequent scarcity of beets, it was decided not to operate the Bay City plant, the Michigan working the beets grown for both concerns.

Owing to the generally good results of the beet crops as compared with other farm crops, farmers are taking considerably more interest. The company is receiving quite an increased acreage for next year. Applications for contracts for next year began to come in early, and the factory already has a large number. There is every indication that its beet acreage will be very much increased.

ALMA.—The plant at this place is one of the most successful beet-sugar factories in the State. This year it underwent extensive repairs and improvements.

The results of beet growing in this district were generally satisfactory. (See Pl. III.) Like most other factories in the State, it failed to secure sufficient acreage to produce a full supply of beets. The crops planted were better cared for, and better results were obtained than usual. Farmers generally are more satisfied with beet growing. Indications are that they will take more readily to beet production than in the past. As with other factories in the State, contracts are being signed much more rapidly and to a larger extent, indicating a full supply of beets for next season.

This season has been quite favorable; the beets have tested well and farmers are feeling more free to contract for the next campaign; still the crop is not thoroughly established with the farmers. It is growing constantly in favor and would grow much faster if it were not for the difficulties encountered in securing the necessary labor.

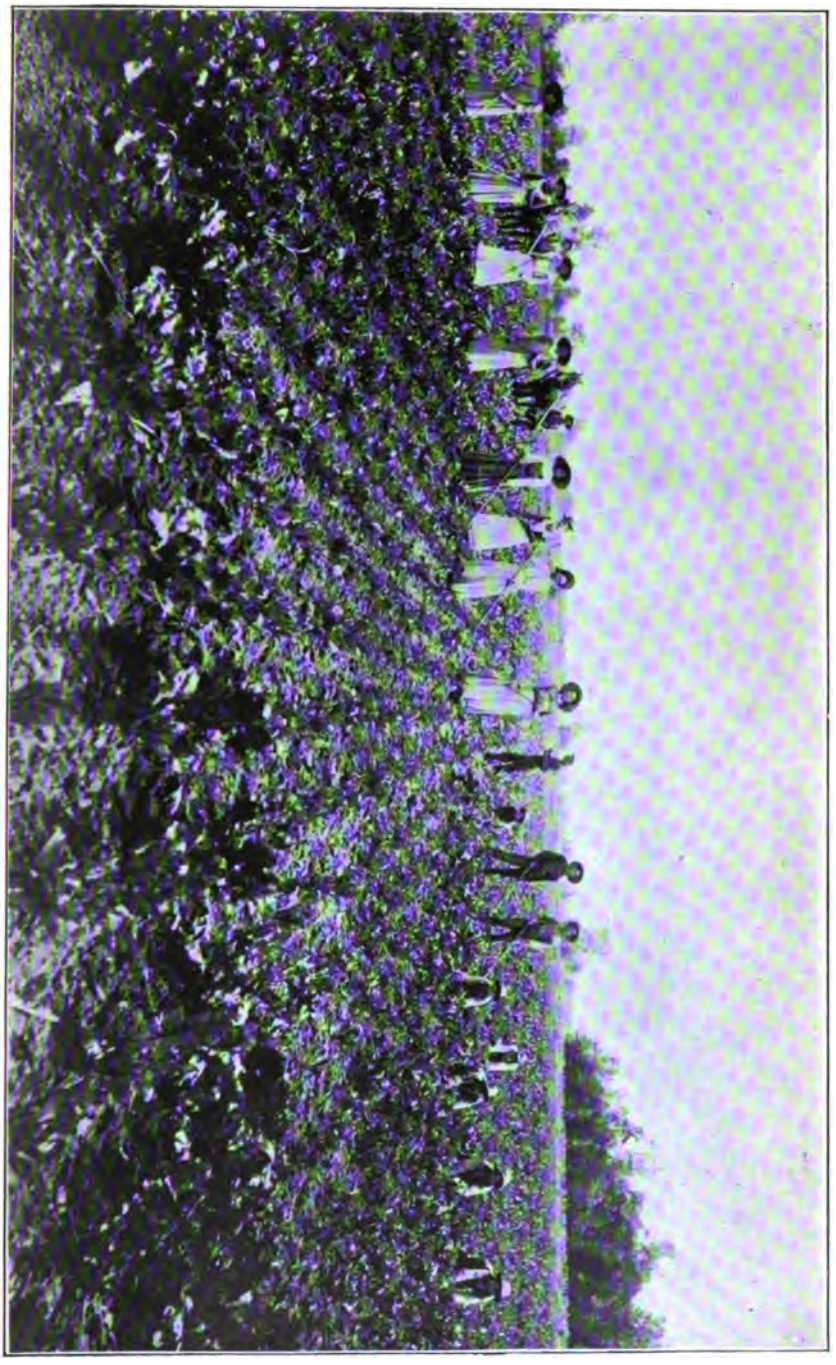
Many think the factories are requiring the farmers in this section of the country to grow their beets with rows too close together. It is claimed the farmers have never been used to cultivating anything in rows as close as 20 inches, and that it causes them to do very slack, slovenly cultivation with implements in use. Good authority in Michigan suggests that, if beets are put in early in rows 26 to 28 inches apart, and thinned to 8 inches in the row, just as good results will be obtained in tonnage and sugar as when they are sown closer together, and that the farmer will do much better cultivation, which means that the crop can be more cheaply raised by the average farmer.

Experience with commercial fertilizers has been quite satisfactory. In some instances no benefit was noticeable, but in most cases the crops increased from 1 to 3 tons per acre. The beet-seed experiments conducted with American seed have shown very favorable results. Larger tonnage and higher sugar contents resulted from the use of American seed. This, of course, means better satisfaction to both the farmer and factory.

The factory had a machine made for the purpose of harvesting and topping sugar beets. It was the first attempt and it did not work well. It had only a short trial, as it was late in completion. It could pull the beets, but it is not a successful topper as yet. Another beet harvester was tried here this fall, and it worked fairly well, and gave evidence that after some more changes are made it may be a practical harvester.

The factory had about 1,000 contracting farmers. It generally uses three or four different kinds of seed, mostly the Kleinwanzlebener.

The prospects for next year seem more favorable than they were



A BEET FIELD NEAR WHEELER, MICH.

for this year at its beginning. Good clay land generally gives the best results in growing the beets.

CARO.—Beet growing for this factory has been quite successful in previous years, as compared with that for other factories of the State. During the past two years there have been some discouragements, however. The springs have been wet, cold, and unfavorable, and there has been very wet weather at harvest time, the first interfering with the planting, germination, and early cultivation of the young beets, and the latter with the harvesting, causing considerable more expense. On this account the factory was not able to secure contracts for as large an acreage as usual. However, under the generally favorable climatic conditions of the season, a much better crop of beets was produced and a larger total yield was received in consequence.

CARROLLTON.—The plant at this place belongs to the same company as the one at Saginaw, in its vicinity. Its farming district grew considerable beets, but these were worked by the Saginaw factory. The season and the results of beet growing were quite similar to those prevalent in the beet-growing district of Saginaw.

CROSWELL.—This factory shared in the favorable conditions for growing sugar beets in the State. The factory did not secure a large acreage, but the land planted to beets, as a rule, received better cultivation. The beet crop generally was much better than at any other time during the operation of the factory. Farmers are much better satisfied and contracts are being signed for a considerably larger acreage next year.

The season has been very good for beet growing, with this exception: The spring was late, backward, and cold, most of the seed being planted about the 1st of June. The summer and autumn were normal. The seasons of 1902 and 1903 were very unfavorable for sugar-beet growing. For this reason many farmers were discouraged and contracts covered a smaller acreage for this year; but the results obtained by the farmers were generally very satisfactory and profitable.

A number of varieties of beet seed were planted, including domestic, grown in the State of Washington, supplied by the Department of Agriculture. This seed, in comparison with foreign seed, was very satisfactory in many ways.

Hill dropping seeders were tried; also blocking machines, but they are not yet satisfactory.

The number of farmers who contracted to grow beets for the factory this year was 650. The factory paid $4.50 per ton for 12 per cent beets, with a corresponding increase or deduction of 33⅓ cents per ton for each per cent of sugar more or less.

Prospects are good for 1905. Farmers are contracting freely, and all have prepared their land in the autumn for the crop.

The seed planted consisted of Mette's Elite, Jeansch's Victrix,

Knauer's Mangold, and Hoerning's Specialital in about equal proportions.

Growers get best results on well-drained, fertile, fall-plowed black ash and elm land, which is a dark clay loam with a blue clay porous subsoil.

EAST TAWAS.—The district around East Tawas shared the generally favorable climatic conditions for growing sugar beets. Crops, during the growing season, were much better cared for, and responded with much better results than hitherto.

The plant has a capacity of 600 tons. The campaign this year was a very short one, being even shorter than that of a year ago, owing to the limited amount of sugar beets received from the small acreage planted. A year ago (1903) the season was very unfavorable and the fall a wet one, the ground freezing up early in November. Some beets were frozen in the ground and those which were harvested had a great deal of earth frozen on them, making the tare very heavy. This, of course, was very unsatisfactory to the farmers; and added to this was the fact that the early appearance of frost prevented fall plowing to any great extent; consequently much of the land was not prepared for sugar beets until spring. Another reason for the small acreage was that the very heavy snow during winter prevented the sugar-beet agents from getting around among the farmers and procuring the contracts. The late disappearance of the snow in the spring, together with the rains that came during the period, left the land in bad shape for early planting with the result that much of the sugar-beet acreage was planted altogether too late. After the beet seed was in the ground, heavy rains followed, then dry weather came, packing the ground, retarding the growth of the beets, and preventing development. However, with a dry fall, tare was very light and the percentage of sugar was very good. This produced a better feeling among the farmers, although the tonnage was light.

No experiments with fertilizers were made to any extent, and the few fields treated were drenched with the rains, and, being somewhat rolling, the effect was lost to a great extent.

Contracts for growing beets were made with 450 families. The factory paid $4.50 per ton, delivered, with an addition of 33⅓ cents for every 1 per cent over the 12 per cent standard.

The kind of land which produces the best beets in this locality, one year with another, is the clay loam that is well drained. This year some of the best results were obtained from sandy loams, and even sandy loams of light nature. While the tonnage on these lands was not what it should have been, it was better than on some of the heavier flat lands not properly drained.

Taking it as a whole, this has been a very poor season in this locality, caused largely by one extreme following another.

HOLLAND.—Beet growing around this factory was very satisfactory during the season of 1904. The factory received contracts for sufficient acreage; early weather conditions were favorable, producing a good stand. The farming community is made up of people of the frugal industrious German type. Apparently it has been one of the most successful factories operating in Michigan. The plant during the summer underwent considerable improvement, especially in the addition of two large beet sheds, materially increasing the storage capacity of the factory. For 1905 prospects are good.

LANSING.—The opening of the season was more favorable this year. The management secured a larger acreage than last year. There was considerably less difficulty in securing labor to do the work in the field. This, with the better yields from the fields, has materially aided the factory in securing contracts for much larger acreage next year.

MARINE CITY.—This plant secured a much larger contracted area for growing sugar beets than last year, approximating 3,000 acres. The weather conditions were somewhat unfavorable the latter part of May and the first part of June. Considerable rain, followed by cold weather, interfered with planting and early cultivation. Through it all the farmers generally secured a good stand, and the weather was quite favorable for cultivation during the months of June and July. This continued up until the harvest was well under way. About the middle of October heavy rains fell; this retarded the work of harvesting and materially affected the sugar contents of the beets for a week or ten days thereafter, after which time better climatic conditions prevailed, and the beets soon assumed their former high sugar contents.

One of the features of beet growing in this vicinity is the interest taken by business men in the beet crop. At this place a club was formed, and a field of 460 acres planted to beets. These were grown under the direction of an expert, the beets were cultivated with care, an excellent stand was secured, and a very satisfactory crop of beets grown.

MENOMINEE.—This factory succeeded in almost doubling its beet acreage this season. The early part was very favorable, and the stand generally good. The season continued normal throughout. The factory received a satisfactory supply of beets. Farmers are generally satisfied with the yield. General results of the year have done much to place the plant on a more substantial basis for future operations. During the summer it received considerable repairs and improvements, especially an increase of the storage facilities for beets.

The normal capacity of this factory is 1,000 tons of beets per day. Several times during the campaign it exceeded this capacity 100 tons or more.

Last year the factory inaugurated the policy of entertaining at the factory its beet growers one day during the campaign. Of these, 3,000

assembled this year, examined the machinery of the enormous plant, saw it in operation, and participated in a general revival of interest. For a new district, the capacity of the factory is a little large. To run this factory 100 days will require about 100,000 tons of beets.

For next year the company has put out a more liberal contract. I am informed that the seed is to be furnished free to the farmers at the rate of 18 pounds to the acre. This is done in order to encourage planting sufficient seed to secure a stand. Where the farmer has to buy the seed there is a tendency to economize in the amount planted. The company agrees to pay the farmer $4.75 a ton for beets delivered in the county. The Menominee River Sugar Company will give away as prizes to sugar-beet growers who raise beets for them 5,000 pounds of granulated beet sugar. All persons growing sugar beets for the company under contract are entitled to compete for the prizes as follows:

For field of 5 acres or more:

First prize—300 pounds of granulated beet sugar: To be given to the grower whose beets bring the largest return in money per acre before anything is taken out for freight or seed.

Second prize—250 pounds of granulated beet sugar: To be given to the grower whose beets bring in the second largest return in money per acre.

Third prize—150 pounds of granulated sugar: To be given to the grower whose beets bring the third largest return in money per acre.

For a field of 2 acres or more, and less than 5 acres:

First prize—200 pounds of granulated sugar: To grower whose beets bring the largest return in money per acre before anything is taken out for freight or seed.

Second prize—150 pounds of granulated sugar: To grower whose beets bring second largest return per acre.

Third prize—100 pounds of granulated sugar: To grower whose beets bring third largest return per acre.

Special prizes will be given to growers in each county from which sugar beets are shipped to this company during the year. All persons growing 2 acres or more of sugar beets under contract for the Menominee River Sugar Company are entitled to compete for these prizes as against all other growers in the same county, prizes to be awarded according to the return in money per acre for fields of 2 acres or over. The special prizes are as follows:

First prize—150 pounds of granulated sugar.

Second prize—100 pounds of granulated sugar.

Third prize—50 pounds of granulated sugar.

All persons who wish to compete for these prizes must notify the company not later than July 1. An agent of the company will call upon those who wish to compete for the prizes and will measure their fields to find out the number of acres contained. The prizes will be awarded on the basis of the factory weight and test of the beets when delivered to the company.

Any grower may compete for the general prize and the county prize also, but both prizes will not be awarded to the same person. The prizes will be awarded as soon as all the returns from the beets can be figured over at the end of the season. Persons who wish to compete and have not contracted for enough acreage may increase their contracts so that they will be entitled to compete at any time before planting. In each case the crop from the whole field will be taken into consideration.

MOUNT CLEMENS.—The season was unusually favorable in this district. It produced the highest average tonnage of any factory district in the State. It had quite a large acreage, and bought several thousand tons of beets grown for the factory at Rochester after that company determined not to operate.

It also had the longest campaign of any factory in the State, the longest in its history. Farmers are very well satisfied with results and are contracting for larger acreage for next year. It is probable that this factory has passed beyond the stage of pioneer difficulties, and that in future it has only to meet those due to abnormal seasons.

Owosso.—The early season was quite favorable. The stand of beets was generally good. Later it was very dry; and it is claimed there was not one month in the year in Shiawassee County that there was not some frost. The rain in the fall helped the crop materially, and it matured very much beyond expectation. Good results in beet growing have done much toward encouragement. The better results are not all attributable to this fact, however. Much is due to the more conservative policies based on past experiences. The factory management insisted on better farming. Road improvement and other facilities are receiving attention.

The harvest of beets was attended with considerable satisfaction throughout the growing area, the farmers receiving the highest average tonnage of any year. Farmers are signing contracts readily for next year. Prospects are bright for a good acreage next year. The farmers are all very much interested and their general talk is favorable to the beet crop.

Experimental work in planting beets in rows 28 inches apart generally demonstrates that they produce as large tonnage at not more than two-thirds the cost.

Experimentation in this district with American-grown seed indicates strong germination, but it is claimed the per cent of sugar was a little lower than that of beets from foreign seed. The tonnage averaged about the same.

A patent blocker tried last year gave very good satisfaction. On one particular field it showed a very good improvement over the hand work. It is also used as a cultivator.

The campaign of the factory lasted forty-three days. The number of contracting farmers was 1,424. The number of acres harvested was 4,902. The price is based on $4.50 for 12 per cent beets with 33⅓ cents for each 1 per cent above that. The average price paid the farmers last year was $5.69.

Experiments with fertilizer have been conducted. It is claimed that where the land is rich and in proper shape fertilizer is of no use except to give beets an early start. The land giving the best results was a clay loam. A fertilizer experiment was conducted on 107 acres,

using from 150 to 200 pounds of fertilizer containing 4 per cent nitrogen, 8 per cent phosphoric acid, and 7 per cent potash. The rows were 28 inches apart. The grain drill was used with the fertilizer attachment.

An experiment to test the proper distance between beet rows was conducted as follows: A 5-acre plot in the center of a 15-acre field was planted with rows 20 inches apart. On either side of this plot 5 acres were planted in 28-inch rows. The same fertilizer and same seed were used. The 20-inch rows cost 94 cents per acre more to cultivate and $7.47 more for blocking and thinning and hoeing than did the 28-inch rows. The average yield per acre for the 20-inch rows was only 46 pounds more than for the 28-inch rows. The average of the 28-inch rows was 10.93 tons of clean beets per acre. According to results here and at other places in Michigan, it is a serious question whether or not the directions for spacing beet rows, given by the best German authorities, are applicable to this locality. Further experiments along this line will follow.

ROCHESTER.—It was determined early not to operate this plant during this season. Considerable acreage of beets, however, was planted. Results were quite favorable. The beets were disposed of to other factories.

It is quite probable that the Rochester plant will be revived and placed in operation for next year. Many farmers and business men have felt its loss keenly, and are making endeavors to induce the company to operate it. Since the loss of its activity has stirred up so much local interest it is probable that when it starts up again the plant will be on a much better footing locally, and that it will continue a career of usefulness with plenty of beets. As indicating the latest movements among those interested, I publish an extract from the Pontiac (Mich.) Press, of December 19, 1904:

The Rochester Beet Growers' Association held its adjourned annual meeting in the town hall Saturday afternoon, and at that time it was decided to make a final effort to secure the required acreage for the reopening of the plant of the Detroit Sugar Company at Rochester.

The new officers elected by the association are as follows: A. L. Ross, president; H. F. Stone, secretary; H. Wattles, treasurer; L. E. Becker, Troy; J. E. Toles, Avon; Thomas Farmer, Washington; William Cundy, Shelby; and George Sweitzer, Oakland, vice-presidents.

H. F. Stone presented a petition from Rochester business men which asked the association to do everything possible to secure the reopening of the sugar plant. The petition was accompanied by a subscription from business men amounting to $510, which is to be used in defraying the expenses of the association in securing contracts for beet acreage.

The communication from the Detroit Sugar Company set forth that the plant will be reopened if the association will guarantee 4,500 acres of beets for the 1905 run. The association has the assurance of 2,500 acres which will be grown near Blissfield. This leaves 2,000 acres to be grown in the territory covered by the 50-cent freight rate from the Rochester plant. This district extends north to Lapeer, south to Royal-

oak, east to Romeo, and west to Pontiac. Beets grown within this district can be shipped to the factory at a freight rate of 50 cents per ton.

Enthusiasm was manifest at the meeting and 137 acres were pledged among the 50 members present. It is estimated that contracts for at least 400 acres can be secured in Troy township. A feature of the meeting was the addresses given on the subject of beets. It was shown that in the five years beets have been raised in Michigan the first two years were unfavorable to the crop and the last three more favorable. The crop has increased in the output per acre and the beets have increased in the percentage of sugar which they contain.

The association will endeavor to hire men at once who will begin a canvass among farmers to secure contracts for acreage. It is expected that another meeting will be held the last of the present week.

ST. LOUIS.—Favorable climatic conditions tended much to better beet crops in the vicinity of this factory. While the acreage was less than in former years, the beets were better both in yield and quality. The fields were better taken care of, showing that farmers are gradually becoming accustomed to this crop.

SAGINAW.—The company operating this plant adopted the policy this year of materially increasing its list of farmers contracting to grow beets and advising them, as a rule, to plant less acreage. This is much more satisfactory, as each farmer with smaller plats of beets can handle the same better, produce relatively larger tonnage with the help at hand, and become more inured to the crop. If this policy could be adopted throughout the State of Michigan it would have a salutary effect. It would be much better, if possible, to confine beet growing to smaller plats and increase the number of farmers engaging in the same.

The yield of beets in this vicinity, although the acreage grown for the factory was much less than desirable, has stimulated a large number of farmers to apply for contracts for next year. The contracts at the close of the campaign were very much in excess of any ever obtained before. It is anticipated now that sufficient acreage will be planted to operate both factories located at this place and owned by this company.

The past season was not particularly favorable for beet growing in this locality. The planting season being very dry, the germination of the seed was low, and the early growth of the beets was stunted. The midsummer was quite favorable, but the cold weather in August and September deterred the growth very materially. While causing a high percentage of sugar, the cold weather matured the crop before it was fully grown, thus reducing the tonnage. Owing to the two previous extremely wet seasons, there was little or no fall plowing done in 1903, leaving the entire work of plowing and fitting the ground for last spring. This made considerable of the planting very late. The beets this season, however, tested better than in previous years.

The beet business is growing in favor with the farmers surrounding the factory, and apparently it will only be a short time when all of the good farmers will be growing beets. The profits derived from the

sugar-beet crop, its durability through adverse weather conditions, and the great benefits of beet pulp for feeding, are influencing the farmers to grow beets. The more familiar they become with the beet crop the more friends it has. They are learning how to properly prepare the ground, plant and cultivate the crop, and the results are more favorable each year.

There is very little fertilizer used in the territory growing the beets. That used is principally barnyard manure, and clover as a green manure; however, in some cases commercial fertilizer has been used with very good results. This company used 100 pounds of nitrate of soda per acre this year on 28 acres of land. This was applied at three different times, and the results were most favorable, giving a large tonnage and also a high sugar percentage. This field of 28 acres averaged over 15 per cent sugar.

It also planted some of the home-grown seed and made a test of it in comparison with Hoerning's Kleinwanzlebener seed, without any particular difference at harvesting time, both running about the same tonnage per acre and about the same average sugar percentage. However, there was a considerable difference in the germinating power in favor of the home-grown seed. It was much more rapid and grew the plants more quickly at the beginning. It is probable that the company will make a more thorough and practical test of this seed another year, as it appeared much nicer, brighter, and more uniform than that from Germany.

The regular seed used is Hoerning's Kleinwanzlebener. It is intended, however, for the next campaign to try several of the leading varieties to determine for a certainty the best adapted to the soil and local conditions. Some beets from Hoerning's seed this year tested from 18.5 to 21 per cent sugar. These are especially good results for the district.

The company had 1,580 contracting farmers. There are two different classes of contracts: (1) To pay $4.50 per ton for 12 per cent beets and 33⅓ cents additional for each per cent over 12; (2) to pay a flat price of $4.75 for beets delivered to railroad stations, or $5 per ton for beets delivered at the sheds.

The prospects for 1905 are brighter than they have ever been since the factory started. It had, as early as the middle of December, as many contracts written for next year as it had altogether for the previous year.

Clay loam and clay produce the best results in the beet-growing territory. The great drawback to beet growing has been that the farmers have not secured large enough yields. A thorough canvass of the territory was made early last fall; every farmer was urged to fall plow some land preparatory to next year's planting. If he decided to grow beets this would give suitable and desirable land for the purpose.

For five seasons past a large part of the labor in the beet fields of

the Caro section has been done by Russian laborers, brought here for the season from Nebraska. They gave such good satisfaction there that last season 10 or 12 carloads of 40 persons each were brought to the Saginaw Valley, and this season 15 carloads were brought here. The number of Russians to be employed in the valley next year will probably be still larger on account of the increased acreage expected. These Russians contract to take care of the beets, doing all hand work, for $20 per acre. They do no machine or team work, only the hand work. Manager Ewen, of the Saginaw Valley Sugar Company, states that they have given good satisfaction here. The 15 carloads this year were distributed through the factories at Saginaw, Sebewaing, East Tawas, and Croswell.

SALZBURG.—The German-American Company is probably the most successful in securing a supply of beets of any of the half dozen factories in the vicinity of Bay City. It is organized on the cooperative plan. Most of the farmers growing beets for it are stockholders in the concern. Its operations in Michigan have proven the cooperative plan to be a good one, especially in localities where competition for the beets is strong. A farmer is more likely to stick to the factory in which he is financially interested. This company secured contracts for a larger area to be planted in beets than for some time. As related to its capacity it probably had a larger supply of beets than any other factory in the State.

The climatic conditions of the season were conducive to the production of a good beet crop and good quality of beets. Results were more generally satisfactory than during any other season since the plant has been in operation.

A large warehouse for storing sugar having a capacity of 3,000 tons of sugar was constructed by this plant.

Often at the time when the beet-sugar factories are in operation prices of sugar tend to fall. In order to benefit by better prices, storage facilities become very desirable. Without them the sugar must go onto the market regardless of the prevailing price. Arrangements for storing sugar should be made by every factory in the United States.

SEBEWAING.—This factory had a larger acreage this year than ever before. It has been more favored in supply of beets than most factories in the State. Having secured contracts for a large area to be planted to beets this year, and the season being generally favorable for beet production, its supply was more than usually satisfactory. The farmers are more contented with the crop. Indications point to greater stability in the operations of the factory in the future.

Encouraged by the present improved conditions, it is announced that the factory will install a plant for drying pulp for next season.

The Sebewaing Huron Company had a sixty days' campaign this

year. The season was dryer than in past years, and the total tonnage less, but the average per acre was better and the percentage of sugar higher. Good satisfaction prevails among growers, and labor is more plentiful.

The factory has about 1,200 contractors, and 3,600 acres were harvested this year. It paid $4.50 for beets testing 12 per cent, and 33⅓ cents per ton more for each 1 per cent of sugar above 12 per cent, with an equal deduction for same rate of decrease.

Prospects for 1905 are better than ever before. The company anticipates contracts for about 5,000 acres.

Hoerning, Dippe, and Original Kleinwanzlebener are the varieties of seed used.

The best results come from heavy clay-bottom soils, which are loamy on top, making a good seed bed.

WEST BAY CITY.—This factory made more of an effort this year to secure contracts with the farmers for a supply of beets. Hitherto it has depended more or less upon farmers to supply it with beets without contracts. This has not usually resulted in a supply sufficient to operate a long campaign. The generally favorable climatic conditions and additional contracts produced for the factory a supply considerably larger than that of 1903. The yield of sugar beets in the vicinity this year has been good. Contracts are being sought by the farmers. Every indication points to a very largely increased acreage.

MINNESOTA.

The progress of the single factory in this State is so marked that it seems unnecessary to discuss conditions except to note its general progress. The general average of beets was 12.32 tons per acre; the average sugar in the beets 15.6 per cent; the average purity 86.

It can readily be seen from these data that conditions are quite favorable for both the farmers and the factory.

ST. LOUIS PARK.—Although this factory enjoyed a very favorable season last year, results for this year are better. The factory secured sufficient contracts to insure a full supply. The season has been remarkably favorable throughout. In its early history this factory had to contend with many things. It was especially difficult to procure sufficient acreage. This obstacle has now been overcome, and the factory is able to secure the choicest land in the State for beet growing. The results of beet growing in the past year are the best of any in the history of the plant.

This year a cyclone partially demolished the plant, damaging it to the extent of $25,000, and this a short time before the opening of its campaign.

In former reports I have called attention to the progress of this factory as it gradually changed from distant or undesirable districts to

those nearer home and from the poorer lands to the best. From year to year the tonnage has been rapidly increasing, as well as the quality of the beets.

The experience of this factory, beginning in 1898, may well be taken as exemplifying the progress of the beet-sugar industry in general during the period it has been in operation. As illustrating the gradual improvement of conditions, I clip from the Minneapolis Tribune of January 13 the following:

It has been found by experiment that beets grow best in the sandy loam characteristic of the southern and southwestern parts of the State, and an effort was made last year to centralize beet culture in this section. That this has proved successful is shown by the fact that, although the acreage this year was 20 per cent less than that of 1903, the production of beets was much greater.

During the year the beets yielded an average of 15.5 per cent of sugar, their range being from 14 to 17.75. In former years the crushing season at the mill has closed about January 1, but this year it will continue until the last of that month. This is due to the increase in the amount of sugar to be milled, and shows that the new industry is rapidly becoming one of the most important in the State.

STATISTICS OF BEET GROWING IN MINNESOTA IN 1904.

Through the kindness and courtesy of Mr. F. W. Fink, president and general manager of the Minnesota Sugar Company, I am enabled to include in this report the following instructive statistics of beet growing in Minnesota for 1904.

The last of these tables shows the remarkable success achieved by a large number of the beet growers. It will be noted that most of these results have been secured by farmers who only attempted to grow small acreage, a point which I have always emphasized. From the data furnished by Mr. Fink, I have computed the acreage results appearing in the last two columns of the last table.

Mr. Fink's letter and accompanying tables follow:

ST. LOUIS PARK, MINN., *January 28, 1905.*

DEAR SIR: Pursuant to our previous correspondence and also to our conversation at the time you visited our factory last fall, I inclose herewith copies of extracts from our authentic beet records.

As you will notice, these statements give the total amount of beet shipments received by us, arranged according to shipping points of the different railroads contributory to our factory, a summary of the total shipments over the different roads, the total amount paid to farmers for beets, and the total amount paid to railroad companies for freight on the same. The difference between gross weight and net weight constitutes the tare (representing dirt and insufficient topping), which, as you will notice, has in most cases been less than 7 per cent, against 9 and 10 per cent in previous years.

I also inclose a statement of these shipments arranged according to counties in which these beets have been produced; also a statement of the results obtained by a large number of the most successful farmers in different beet-growing districts of Minnesota, which, as you will admit, have been most excellent compared with those of previous years.

I hope that these documents will be of some value to you in compiling your report, and in case you desire any additional information be good enough to advise me to that effect.

Very respectfully, yours,

F. W. FINK,
President and General Manager.

Mr. C. F. SAYLOR,
Des Moines, Iowa.

Beet shipments received by the Minnesota Sugar Company during the campaign of 1904 over several lines of railway.

THE "SOO" LINE.

Name of station.	Number of car-loads.	Gross weight of beets.	Net weight of beets.	Land in beets.	Amount paid for beets.	Amount paid for freight.
		Tons.	*Tons.*	*Acres.*		
Hamel	10	228	208	18¼	$911.43	$126.65
Loretto	2	28	27	2	121.86	17.50
Rockford	1	10	9	1	41.68	11.50
Maple Lake	3	90	83	5	375.09	61.71
Annandale	28	695	643	51½	2,885.21	566.27
South Haven	9	225	210	17	942.78	180.75
Kimball Prairie	12	316	293	29	1,320.82	253.78
Watkins	13	411	372	31¼	1,680.38	323.91
Eden Valley	17	460	425	36	1,917.71	350.47
Buffalo	4	91	89	5	392.25	65.45
Total	99	2,549	2,354	196	10,589.21	1,967.99

CHICAGO, MINNEAPOLIS, ST. PAUL AND OMAHA RAILWAY.

Nichols	2	41	38	2	$174.62	$24.89
Belle Plaine	9	205	190	18	881.49	124.26
East Henderson	5	102	94	8	426.03	71.24
St. Peter	5	68	65	5¼	296.01	64.01
Caroline Siding	1	31	29	2	133.03	26.74
Traverse	1	20	19	1½	85.52	25.80
Oshawa	5	101	95	8	429.52	131.80
Courtland	1	16	15	1	68.25	23.00
Cambria	3	83	78	5	353.55	109.07
Judson	8	181	172	5	803.55	208.23
Spring Valley	1	19	17	1	78.66	21.19
Menominee Junction	1	30	28	2	128.48	28.60
Weston	1	22	21	1½	95.42	25.30
Beldenville	3	66	61	4	277.46	47.17
Deer Park	2	31	28	3	130.66	28.59
Total	48	1,016	950	77¼	4,362.25	960.07

CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY.

Chanhassen	1	19	18	2	$83.35	$9.80
Benton Junction	1	19	18	2	83.57	9.83
Cologne	8	218	200	15½	903.88	108.61
Bongards	11	258	239	22	1,079.56	157.09
Norwood	5	98	92	6	416.36	64.69
Plato	3	76	72	7	326.32	50.31
Glencoe	74	1,726	1,620	119½	7,297.32	1,085.86
Bigstone City	8	204	198	18	896.08	271.88
Biscay	3	60	56	6	254.37	43.56
Minnehaha	2	45	42	5	200.95	15.83
Mendota[a]	23	500	461	33	2,076.85	298.89
Westcott	9	174	162	17	731.51	33.05
Rosemount	1	22	21	2	93.90	13.32
Castlerock	2	48	44	4	201.60	28.76
Dundas	1	21	20	2	90.15	12.96
Medford	23	426	403	35	1,816.05	295.19
Owatonna	19	386	366	33	1,650.03	337.15
Vermilion	3	50	47	4	215.21	34.03

[a] Two carloads of the 23 were shipped via the Chicago, St. Paul, Minneapolis and Omaha Railway.

Beet shipments received by the Minnesota Sugar Company during the campaign of 1904 over several lines of railway—Continued.

CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY—Continued.

Name of station.	Number of carloads.	Gross weight of beets.	Net weight of beets.	Land in beets.	Amount paid for beets.	Amount paid for freight.
		Tons.	*Tons.*	*Acres.*		
Lakeville	3	42	40	4	$180.44	$27.37
Elko	18	400	374	34½	1,680.29	241.80
Lonsdale	35	713	677	68	3,227.22	505.47
Lesueur Center	48	1,180	1,072	82	4,913.85	813.02
Hastings	2	38	36	2	160.31	28.50
Hutchinson	14	271	252	22½	1,139.89	189.98
Total	317	6,989	6,520	546½	29,718.80	4,677.01

NORTHERN PACIFIC RAILWAY.

Forestlake	8	85	80	8	$361.03	$67.32
Littlefalls	6	113	106	22	481.11	118.05
Flensburg	8	204	189	40½	853.78	223.73
Total	17	402	375	70½	1,695.92	409.10

MINNEAPOLIS AND ST. LOUIS RAILWAY.

Waconia	35	984	810	96	$3,265.75	$446.45
Young America	19	454	422	34½	1,899.73	272.41
Hamburg	8	190	179	13	806.05	114.47
Green Isle	2	38	36	3	163.85	23.83
Arlington	38	1,075	987	93½	4,444.52	645.34
Gaylord	14	352	317	40	1,429.84	250.08
Winthrop	10	221	208	20	888.11	155.25
Gibbon	1	29	27	2	120.41	20.32
Morton	10	237	224	19	1,008.68	201.86
Lafayette	5	85	79	8	359.61	59.21
New Ulm	8	173	163	13	738.07	147.74
Hanska	7	156	147	15½	661.15	142.71
Chaska[a]	63	1,570	1,468	110	6,611.97	785.08
Carver	14	348	323	26½	1,454.99	174.03
Merriam Junction	22	574	539	55	2,461.47	287.04
Jordan	15	316	297	25	1,339.08	194.74
Helena	8	129	120	11	540.73	77.54
New Prague	64	1,629	1,513	105½	6,818.78	978.56
Suchomels Crossing	69	1,930	1,795	144½	8,401.40	1,195.04
Montgomery[b]	180	5,263	4,928	318½	22,682.13	2,842.80
Mulfords	32	759	717	53	1,088.66	153.70
Kilkenny	20	513	479	43½	2,163.89	360.62
Waterville	10	202	195	17½	857.12	145.75
Total	654	17,227	15,973	1,267½	70,155.99	9,674.57

CHICAGO, BURLINGTON AND QUINCY RAILWAY.

Maiden Rock	4	101	95	6½	$430.28	$81.94
Pepin	3	59	55	6	251.73	70.38
Total	7	160	150	12½	682.01	152.32

WISCONSIN CENTRAL RAILWAY.

Glenwood	4	53	49	5	$222.69	$52.57
Downing	2	39	36	2½	163.95	40.70
Forrest	2	19	17	2	80.17	28.34
Total	8	111	102	9½	466.81	121.61

[a] Of the 63 carloads 33 were shipped via the C., M. & St. P. Rwy.
[b] Of the 180 carloads 7 were shipped via the C., M. & St. P. Rwy.

Beet shipments received by the Minnesota Sugar Company during the campaign of 1904 over several lines of railway—Continued.

GREAT NORTHERN RAILWAY.

Name of station.	Number of carloads.	Gross weight of beets.	Net weight of beets.	Land in beets.	Amount paid for beets.	Amount paid for freight.
		Tons.	*Tons.*	*Acres.*		
Long Lake	6	134	125	10½	$561.35	$83.25
Maple Plain	4	128	120	10	544.16	79.86
Delano	5	70	55	6	251.04	50.67
Montrose	2	27	25	2	115.85	22.40
Cokato	20	553	512	40½	2,308.42	382.80
Dassel	55	1,737	1,629	127	7,174.21	1,364.59
Darwin	14	273	257	19½	1,159.33	271.98
Litchfield	4	83	72	8½	348.65	68.96
Grove City	1	15	14	1½	60.66	13.06
St. Bonifacius	1	10	9	1	42.02	11.50
Maple	23	645	599	50	2,698.40	444.69
Mayer	13	305	282	21½	1,281.41	215.67
Silver Lake	7	100	93	6	424.35	93.27
Bock	1	21	19	1½	90.82	17.22
Mora	1	19	17	1½	79.55	18.72
Robbinsdale	5	143	139	9	643.47	86.18
St. Michaels Station	5	98	91	7	411.08	72.16
Nelson	3	56	52	4	235.57	72.52
New Germany	2	41	39	4	175.91	29.76
Total	172	4,458	4,149	330½	18,606.25	3,399.30

CHICAGO GREAT WESTERN RAILWAY.

Empire	1	27	26	2	$115.05	$18.82
Dodge Center	1	20	18	1½	81.88	19.18
Waltham	2	115	109	7	497.54	136.57
Mayville	2	29	28	2	134.26	36.44
Morristown	3	77	71	7½	323.46	56.90
Elysian	12	254	242	22½	1,068.95	246.60
Eagle Lake	.....	18	17	11½	80.80	18.55
Madison Lake	4	80	76	5½	342.27	76.27
Simpson	5	122	114	8	515.02	136.32
Faribault [a]	22	415	391	40½	1,757.89	314.41
Mankato [b]	28	588	551	45½	2,477.76	507.32
Total	84	1,745	1,643	143½	7,394.88	1,567.38

DELIVERED BY WAGON.

St. Louis Park and vicinity	.....	225	211	20	$1,057.80	.....

[a] Of the 22 cars, 2 were shipped via the Chicago, Milwaukee and St. Paul Railway.
[b] One car of the 28 was shipped via the Chicago, St. Paul, Minneapolis and Omaha Railway.

Summary of beet shipments received by the Minnesota Sugar Company during the campaign of 1904.

Railway.	Land in beets.	Number of carloads.	Gross weight of beets.	Net weight of beets.	Amount paid for beets.	Freight paid.
	Acres.		*Tons.*	*Tons.*		
Soo Line	196	99	2,549	2,354	$10,589.21	$1,967.99
Chicago, Minneapolis, St. Paul and Omaha	77½	48	1,016	950	4,362.25	960.07
Chicago, Milwaukee and St. Paul	516½	317	6,989	6,520	29,718.80	4,677.01
Minneapolis and St. Louis	1,267½	654	17,227	15,973	70,155.99	9,674.87
Great Northern	330½	172	4,453	4,149	16,606.25	3,399.30
Chicago Great Western	143½	84	1,745	1,643	7,394.88	1,567.38
Chicago, Burlington and Quincy	12½	7	160	150	682.01	152.32
Wisconsin Central	9½	8	111	102	466.81	121.61
Northern Pacific	70½	17	402	375	1,695.92	409.10
St. Louis Park—wagon deliveries	20	.....	225	211	1,057.80	.....
Total	2,673½	1,406	34,877	32,427	144,729.92	22,929.35

Beet shipments received by the Minnesota Sugar Company during the campaign of 1904, by counties.

County.	Number of carloads.	Gross weight of beets.	Net weight of beets.	Land in beets.	Amount paid for beets.	Amount paid for freight.
		Tons.	*Tons.*	*Acres.*		
Carver	203	5,144	4,679	403	$20,760.67	$2,832.58
Sibley	79	2,022	1,859	184¼	8,304.25	1,290.32
Renville	10	237	224	19	1,008.68	201.86
Nicollet	17	290	273	23¾	1,238.91	304.00
Brown	18	412	388	33¼	1,752.77	299.52
Scott	127	3,048	2,843	231¼	12,840.33	1,779.68
Lesueur	371	10,101	9,428	681¼	41,176.00	5,757.53
Stearns	12	316	293	29	1,320.82	253.78
Steele	42	812	769	68	3,466.06	632.34
Hennepin	30	941	876	75¾	4,083.04	430.81
Wright	77	1.849	1,717	135	7,723.40	1,413.71
Meeker	104	2,979	2,769	223¼	12,340.94	2,393.01
Dakota	46	942	875	70	3,949.49	557.63
Blue Earth	31	898	845	69¼	3,837.41	837.11
Pierce, Wis	8	186	173	11¼	786.40	150.30
Dunn, Wis	2	52	49	3¼	223.90	53.90
St. Croix	20	142	130	12¼	597.47	150.20
Washington	3	85	80	8	361.03	67.32
Morrison	14	317	295	62¼	1,334.89	341.78
Pepin, Wis	3	59	55	6	251.73	70.38
Dodge	1	20	18	1¼	81.88	19.18
Mower	8	144	137	9	631.80	173.01
Rice	61	1,226	1,159	117¾	5,398.72	889.76
Olmsted	5	122	114	8	515.02	136.32
McLeod	101	2,233	2,093	161¼	9,442.25	1,412.98
Millelacs	1	21	19	1¼	90.82	12.22
Kanabec	1	19	17	1¼	79.55	18.72
Douglas	3	56	52	4	235.57	72.52
Brant, S. Dak	8	204	198	18	896.06	271.88
Total	1,406	34,877	32,427	2,673¼	144,729.92	22,929.35

Results secured in 1904 by 112 of the most successful farmers growing beets for the Minnesota Sugar Company.

Locality.	Name of grower.	Land in beets.	Gross weight of beets.	Net weight of beets.	Gross proceeds.	Net proceeds.	Yield per acre.	Net proceeds per acre.[a]
		Acres.	*Tons.*	*Tons.*			*Tons.*	
Hamel	Peter Morin	2¼	120,200	105,175	$236.64	$214.58	21	$85.83
Buffalo	O. E. Stromberg	2	125,600	.....	266.90	267.35	.....	133.675
Maplelake	Onesime Hinso	3	123,900	115,500	259.87	229.79	19.2	76.60
South Haven	Carl Muehring	3	115,850	107,730	242.39	205.98	18.8	68.66
Eden Valley	Jos. Moser	2	81,605	75,485	169.84	150.70	18.8	75.35
Do	N. P. Rothstein	1	33,400	31,395	70.64	62.68	15.6	62.68
Do	N. H. Schreifels	1	47,600	45,220	101.74	91.86	22.6	91.86
Do	Chr. Schuetz	1	46,960	43,250	97.31	86.57	21.6	86.57
Do	Math. Thielen	2	101,080	92,720	208.62	190.61	23.1	95.30
Long Lake	Jerry Hannen	1	46,800	43,290	97.40	87.94	21.6	87.94
Mapleplain	C. A. Swonson	1	43,900	41,925	94.33	85.00	20.96	85.00
Dassel	John Almquist	2	83,170	76,520	172.17	146.97	19.1	73.48
Do	P. A. Anderson	1¼	77,890	71,660	161.24	139.07	23.8	92.71
Do	Daniel Danielson	4	150,335	135,930	305.83	255.28	16.9	63.80
Do	P. J. Sallberg	1	44,440	40,885	91.99	77.67	20.4	77.67
Do	P. A. Swedelius	1	43,335	40,300	90.67	77.15	20.1	77.15
Darwin	A. Lindquist	1	71,460	66,845	150.40	131.70	33.4	131.70
Maple (P. O., Waconia).	L. Schindele	20	693,650	649,615	1,461.63	1,321.92	16.2	66.09
Mayer	Chas. Haueter	1¼	81,600	76,295	171.66	151.41	25.4	100.94
Silver Lake	F. B. Zolk	1	53,500	49,550	111.51	91.43	24.7	91.43
Hutchinson	Wencel Oliva	2	78,225	72,935	164.10	143.52	18.2	71.76
Do	Jos. Zoodlik	1	44,900	42,280	95.13	82.33	21.1	82.33
Norwood	Peter Effertz	4	179,016	167,661	377.23	341.07	20.9	85.26
St. Louis Park	F. Schillinger	2	80,640	75,470	188.68	185.68	18.8	92.84
Waconia	Albert Burandt	2	82,100	78,385	176.37	161.37	19.5	80.68
Do	John Kelzer	1	42,646	38,590	86.83	79.29	19.3	79.29
Do	Henry Schwartz	1	42,123	38,330	86.24	80.83	19.2	80.83
New Ulm	Ernst Fritche	2	89,800	84,920	191.07	168.45	21.2	84.23
Hanska	Knud O. Lee	1	39,600	37,025	83.31	72.93	18.5	72.93
Do	Jacob Synsteby	1¼	75,600	70,640	158.91	134.22	23.5	89.48
Nichols	Michael Barry	2	83,006	77,611	174.62	159.45	19.4	79.73
E. Henderson	F. M. Spencer	1	43,520	40,040	90.09	86.32	20	86.32
Chaska	Leonard Ess	30	971,580	906,790	2,040.28	1,886.41	15.2	62.88
Do	Adam A. Schaefer	2	79,145	74,790	168.27	156.37	18.6	78.18

[a] Deductions from gross proceeds are made for freight, cost of seed, and use of machinery.

Results secured in 1904 by 112 of the most successful farmers growing beets for the Minnesota Sugar Company—Continued.

Locality.	Name of grower.	Land in beets.	Gross weight of beets.	Net weight of beets.	Gross proceeds.	Net proceeds.	Yield per acre.	Net proceeds per acre.
		Acres.	*Tons.*	*Tons.*			*Tons.*	
Helena	John Stocker	3	115,400	109,405	$246.16	$219.20	18.2	$73.06
Jordan	Peter Stocker	2	91,100	85,125	191.53	170.84	21.3	85.42
New Prague	F. J. Bartusok	2	77,390	72,055	162.12	146.75	18	73.38
Do	Ignac Fierst	4	166,800	173,775	354.90	322.34	21.97	80.58
Do	John Kubes	2	109,560	101,730	228.80	209.29	25.4	104.65
Do	Math Kucera	1	43,950	41,025	92.31	84.11	20.5	84.11
Do	Frank J. Lukes	2	127,970	118,295	266.16	243.76	29.57	121.88
Do	Frank Minara	2	76,800	71,515	163.32	148.97	17.8	74.49
Do	Thomas Novak	1	38,230	35,430	79.72	71.44	17.6	71.44
Do	J. Schoenbauer	1	54,840	51,940	117.11	107.07	25.97	107.07
Do	John J. Svoboda	1½	63,370	68,585	131.82	119.29	22.8	79.46
Do	John W. Tupy	1	53,860	49,120	110.52	103.54	24.5	103.54
Do	Thos. Zvanovec	3	140,990	131,140	295.07	268.69	21.8	89.53
Suchomels Crossing	John Dvorak	1	42,690	40,340	90.77	82.48	20.2	82.48
Do	Peter Dvorak	1½	62,330	57,345	129.02	116.49	19	77.66
Do	Joseph Fuerst	3	113,160	106,955	242.15	219.15	17.88	73.05
Do	Frank Fried	2	84,000	79,475	180.32	163.91	19.87	81.96
Do	Joseph Hajney	1	38,410	36,105	81.23	73.23	18	73.23
Do	Frank Hruby	4	146,640	138,390	313.88	282.26	17.2	70.56
Do	Jacob Odenthal	2	74,300	69,625	156.66	140.72	17.4	70.36
Do	John Studnicka	1	38,230	35,745	80.42	72.45	17.87	72.45
Do	Thomas Uhlirs	3	132,180	124,610	283.41	262.29	20.6	87.43
Montgomery	Carl Augst	10	437,360	407,665	917.25	838.59	20.38	83.86
Do	Aug. Bury	5	188,970	177,400	399.15	362.08	17.7	72.40
Do	Jerry Carpenter	5	185,615	174,160	411.45	371.00	17.4	74.20
Do	Anton Cordes	2	101,940	95,445	214.75	196.11	23.86	98.05
Do	T. K. Daleiden	2	143,930	134,615	302.88	276.45	33.65	138.23
Do	John J. Deitz	3	115,560	108,680	251.68	227.63	18.1	75.88
Do	Herman Eisert	5	325,740	303,720	683.37	624.36	30.37	124.87
Do	Wencel Factor	3	156,090	146,925	330.58	301.47	26.72	100.49
Do	Albert Flicek	1	48,010	44,779	117.52	99.67	22.38	99.67
Do	John Flicek	4	151,290	142,227	320.00	289.29	17.78	72.32
Do	John Holy	2	80,530	75,795	170.54	151.63	18.95	75.81
Do	Albert Janovsky	3	121,710	114,200	256.98	232.89	19	77.63
Do	John Koubele	6	254,760	239,125	538.03	685.49	19.9	114.24
Do	John H. Koubele	2	89,380	83,195	187.19	170.11	20.77	85.05
Do	Albert Krocak	3	125,290	116,880	262.98	237.73	19.46	79.25
Do	F. M. Kukacka	2	111,300	108,960	233.91	209.40	25.99	104.70
Do	J. F. Kukacka	5	235,610	219,880	294.73	450.58	21.96	90.11
Do	Jos. R. Kukacka	2	120,650	112,390	252.88	228.90	28.1	114.45
Do	Karl Linberger	6	238,040	224,290	504.65	454.20	18.7	75.70
Do	Joseph Loula	2	84,660	80,155	180.35	169.62	20	80.31
Do	Agnes Mach	4	202,590	189,340	426.01	385.89	23.7	96.47
Do	Leopold Mixa	2	94,060	89,800	202.05	181.59	22.4	90.79
Do	Annie Novotny	3	159,010	148,325	347.08	313.26	24.7	104.42
Do	Frank Rehor	2	83,910	79,870	179.71	161.07	19.97	80.53
Do	John Retka	2	74,600	70,605	158.86	142.64	17.6	71.32
Do	M. Soulek	2	75,040	71,240	160.80	145.52	17.8	72.76
Do	Mat. Skluzacek	2	85,290	80,005	189.00	171.44	20	85.72
Do	M. F. Starck	3	118,440	111,210	250.22	226.57	18.5	75.52
Do	Frank J. Staska	2	96,050	91,120	205.18	185.27	22.8	92.63
Do	Frank Troka	3	118,530	111,375	250.59	226.92	18.6	75.64
Do	John Tupy	1	43,650	41,020	92.30	83.09	20.5	83.09
Do	John Vlasek	6	241,110	229,180	515.65	466.31	19	77.71
Mulfords	John Felipek	2	101,100	93,080	213.82	194.53	23.3	97.26
Do	A. Horazdovsky	3	145,600	134,895	311.10	282.55	22.5	94.18
Do	Jas. Kopot	2	73,000	69,350	156.04	140.01	17	70.00
Do	John Sladek	3	120,700	114,170	258.55	233.86	19	77.95
Do	Frank Watzek	1½	58,700	55,470	124.81	112.42	18.5	74.95
Kilkenny	Jos. Stangler	2	75,810	71,320	160.47	140.29	17.8	70.15
Mendota	Joseph Labbie	3	114,905	105,560	237.73	219.02	17.6	73.00
Do	Rubon Lemay	2	91,380	84,395	189.89	175.64	21.1	87.82
Do	F. W. Trapp	1	37,733	34,905	78.53	72.76	17.5	72.76
Do	Jno. Wagenknecht	2	97,240	90,030	202.57	188.38	22.5	94.19
Elko	John Wagner	1	37,620	34,800	78.30	70.15	17.4	70.15
Lonsdale	Martin Coplecha	1½	52,990	49,935	131.08	107.48	16	71.65
Do	Joseph Kalina	2	99,060	91,145	211.83	186.50	23.5	93.25
Do	Thos. Pumper	1	46,800	44,495	100.11	88.47	22.24	88.47
Le Sueur Center	August Ehmke	1	55,195	52,050	117.11	104.00	26	104.00
Do	Conrad Lang	1½	43,995	41,005	92.26	82.86	13.6	55.24
Do	Julius Maronde	1	40,690	38,250	86.06	75.49	19	75.49
Do	Frank Picka	1	37,900	35,860	80.68	70.60	17.9	70.60
Do	F. Preuss	1	49,360	46,090	103.70	91.61	23	91.61
Do	Wm. Tiede	1½	62,015	58,130	130.79	114.89	19.4	76.59
Do	Aug. Traxler	1	45,900	43,675	98.27	86.79	21.8	86.79
Do	Sig. Traxler	2	95,515	89,640	201.69	178.33	22.4	89.16
Hastings	Chas. Freitag	2	75,800	71,250	160.31	144.68	17.8	72.34
Maiden Rock, Wis.	E. J. Sjostrom	1½	59,000	66,050	126.11	109.24	18.7	72.82

NEBRASKA.

There is to be noted a general improvement of conditions and results throughout Nebraska. These are influenced principally by the employment of the irrigated lands in the western part of the State for beet growing. Each of the factories secures nearly as many beets from the irrigated districts of the west as in its immediate vicinity.

The American Beet Sugar Company is removing its factory from Norfolk to Lamar, Colo.

The following is a summary of the average results for these factories during the year:

The average acreage of the factories was 4,366 acres.
The average yield per acre was 9.41 tons of beets.
The factories worked an average of 41,100 tons of beets.
They produced in sugar an average of 9,791,333 pounds, or 4,895.6 short tons.
The sugar in beets averaged 15.08 per cent; the purity 81.48.
The sugar factories paid the farmers for beets approximately $616,500.

GRAND ISLAND.—During the past two years this factory has been much more successful than in previous years. This is largely due to the opening up of the western part of Nebraska to beet growing, its location being much nearer than the rest.

The factory is paying a higher rate than formerly. It now pays a flat rate of $4.50 per ton. The high grade of beets grown in the western part of the State, which contributes the greater part of the supply, will sustain this price. It pays 25 cents extra for handling and 20 cents additional for beets that have been siloed awaiting a call from the factory.

Beet growing in its own vicinity, as well as in the western district, was very satisfactory and encouraging, both in tonnage and quality of the beets. Beet growers near the factory probably secured the best yield for several years.

LEAVITT.—This factory (near Ames) had a larger area contracted and planted to beets this season than ever before. A large part of its beets also are now grown in the western part of Nebraska. The management for a number of years has secured the control of considerable territory in that section, especially lands under irrigation from the Culbertson ditch.

The principal obstacle to growing beets in the western part of the State has been the lack of help on the farms. Gradually this situation is improving.

During the season this company conducted experiments with commercial fertilizers in cooperation with the Department of Agriculture under the direction of Doctor Townsend of the Department.

Frequent rains in June gave the weeds considerable start, causing difficult cultivation. This was true not only of the best fields near the factory, but also of the fields in the western part of the State where

irrigation is employed. Beets grown in this part of the State this year were matured almost entirely without irrigation.

Beets grown near the factory in the eastern part of the State were up to the standard, compared with those of any other year since the factory has been in existence. Sufficient rain fell to produce a crop, after which followed a dry spell, elaborating the sugar in the beets and producing high quality.

Throughout the campaign of this year the beets averaged over 15 per cent sugar.

The management of this factory announces that it will pay a flat rate of $5 per ton for beets next year. At the rate contracts are coming in, 8,000 acres are anticipated for the next campaign.

I submit a report made by Mr. H. Scilley, the agriculturist of the Standard Beet Sugar Company, at Leavitt. Mr. Scilley is one of the most careful and progressive beet growers in the country. His report is as follows:

LEAVITT, NEBR., *December 20, 1904.*

DEAR SIR: The Standard Beet Sugar Company is located at Leavitt (near Ames), Dodge County, Nebr. The length of the campaign this year will be about one hundred and sixteen days.

The past season has been, on the whole, favorable to beet growing. It was very dry in the spring in the irrigated districts in the western part of the State. A large acreage was grown for this factory, and a large portion of the land had to be irrigated before it was plowed. When the rains did start they were continuous for some time, so that the crop was rather late in a good many places. We succeeded, however, in getting a fairly good stand, which was considerably damaged in sections by heavy hail storms later in the season.

The beet crop is growing in favor with the farmers in our territory, especially in the western part of it, as the price now paid for beets enables the farmer to make a good profit on a moderate tonnage. In the eastern part of the State it is also growing in favor from the same cause, but the size of the farms in the eastern part of our territory operates against the industry, as a farm of 160 to 240 acres can be farmed to corn or grain with a small amount of help, and the average farmer does not care to handle a crop requiring a large amount of help.

The principal developments this year favorable to beet growing have been the better handling of water in the irrigated territory and the cultivation of the crop as soon after watering as possible. This we have tried to have done, and it has greatly increased the yield.

In our eastern territory we have found that land subject to leaf spot if planted late will be very slightly affected, as by the time the plants get large enough to catch the infection the nights have become cool, rendering the conditions unfavorable for the development of diseases of this kind.

Several experiments have been conducted with artificial fertilizers by our beet growers this season, but without any apparent results, whereas the application of well-rotted barnyard manure has again given a greatly increased yield and has pretty conclusively proven itself to be away ahead of any commercial fertilizer. The different varieties of beet seeds we experimented with this year have all proved very satisfactory, especially that grown by Mr. E. H. Morrison, Fairfield, Wash.

A new beet-topping machine, brought out a year ago, was tried and does excellent work, pulling, topping, and putting the beets in windrows at right angles to the

direction in which the rows run, the same as a hayrake leaves hay. No other new labor-saving implements have been tried this year.

We had contracts with 400 farmers this year. We harvested 5,900 acres.

We paid $4.50 and $5 per ton for beets this season, and are making our new contracts at $5 on track.

The prospects are very good for 1905, and we are looking for an increased acreage.

The seeds we used this season are as follows: Original Kleinwanzlebener, 40 per cent; Aderstedt, 20 per cent; Dippe Kleinwanzlebener, 20 per cent; Braune's Elite, 5 per cent; Schreiber's, 6 per cent; Knaur's Mangold, 6 per cent; Naarden, 1 per cent, and Morrison, 2 per cent.

The lands giving us the best results are the rather heavy sandy loam soils that are free from surface water and yet not too far from moisture. The tableland in the western part of the State, where the soil is a sort of a magnesia clay, also gives us excellent results when properly watered.

The beet crop is rapidly becoming more permanent, as we are getting now a line of growers that make a practice of growing a fixed acreage each year, preparing their land one year ahead, and they are having such good results that it is encouraging their neighbors to try it also. It is only a question of a few years when the manufacturers of sugar will be justified in putting up additional factories in Nebraska. The quality of the beets for the last two campaigns has been as good as at any point in the Western States, California possibly excepted.

Yours, very truly, H. SCILLEY,
Agriculturist of the Standard Beet Sugar Company.

The beet-growing interest of the Standard Beet Sugar Company in the western part of Nebraska is under the superintendency of Mr. James Scilley, who is also a practical beet grower.

Desiring to follow in detail the progress of sugar-beet growing in the western part of Nebraska, I requested Mr. Scilley to make a report on this work, which is as follows:

NORTH PLATTE, NEBR., *December 26, 1904.*

DEAR SIR: Yours of the 21st received. I am glad to inform you that the sugar-beet acreage in western Nebraska was considerably increased this year, and that the results have, as a whole, been very satisfactory to the growers as well as to the factory. The Standard Beet Sugar Company had about 2,500 acres in the North Platte Valley and the American Beet Sugar Company about the same amount, making a total of 5,000 acres in all.

Quite a number of farmers employed Russian help, putting in all the way from 30 to 125 acres; for instance, Dolan & Clarke, of Vromin, put in 120 acres, getting Russians to do the hand work. The beets netted around 15 tons to the acre at $5 per ton, which gave the growers a very handsome profit. These beets were delivered to the American Beet Sugar Company, Grand Island.

At Maxwell, Nebr., Ed. Hostetter had 5 acres, and made a little over 20 tons to the acre; Harry Pell had 3 acres which made 25 tons, and 2 acres, 18 tons per acre; Carny Hutchinson had 5 acres which made about 16 tons to the acre; E. E. Hardisty had 10 acres which made 16 tons to the acre; John Shaver, 20 acres with about 18 tons per acre; Scott Shaner, 9 acres with 15 tons per acre; August Larson, 5 acres with 15 tons per acre. All of these, with many others, were delivered to the Standard Beet Sugar Company, and the growers received $5 per ton on track at Maxwell.

At Brady Island E. W. Murphy had some 5 acres which made 18 tons to the acre; Joseph McGee, 15 acres which made 17 tons to the acre, and many others raised from 12 to 15 tons per acre.

At North Platte we unfortunately had a very severe hailstorm, which destroyed all other crops and reduced the tonnage on the beet crop so that we got in this district from 6 to 13 tons to the acre. The North Platte Sugar Beet Company had 127 acres that made somewhere in the neighborhood of 8 tons per acre. This low tonnage was caused partly by the hail and partly by the irrigation ditches going dry, so that when the foliage was destroyed the ground dried out very rapidly and beets did not get started again until several weeks later, when we had rains enough to supply moisture.

Growers having a large acreage could not get over the ground fast enough with cultivators to conserve moisture. William Longrath, in the same territory, raised about 12 tons to the acre on 28 acres. Mr. Longrath got into his field immediately after the hail and stirred the soil, giving his beets a chance to recuperate.

Let me say here that, in my opinion, where beets are of good size and are stripped of their entire foliage by hail, if farmers, instead of getting discouraged, will go ahead and cultivate properly they need suffer very little from the effects of the hail. (See Pls. I and II.) While the hailstorm reduced the yield in this territory, it will be the means of very largely increasing the acreage in 1905, as a good many farmers lost all their other crops, but where they had sugar beets their beets made a fair showing.

Mr. L. F. Waugh, of North Platte, had 10 acres of beets that he did not get planted until about the 25th of June. All his other crops were entirely destroyed by the hailstorm, but his beets made 8 tons per acre; as he did the work with his own family, it made him a nice little bit of money. A. T. Warnack had a little over 9 tons per acre on 30 acres in the same territory. Joseph McConnell, on a 5-acre tract at Hershey, raised 20 tons to the acre. This particular piece of ground had never raised a crop before on account of the cold alkali nature of the soil.

George Mudd, of Hershey, had 80 acres that yielded from 10 to 18 tons per acre, the hand work being done by Russian help. He cleared something like $3,000 on his crop. These beets were delivered to the American Beet Sugar Company. Louie Tollior, of Hershey, grew 20 acres for the Standard Beet Sugar Company, on which he cleared $41 per acre.

Alexander Nielson had 10 acres in for the Standard Beet Sugar Company, which yielded 15 tons to the acre. W. H. Graham, of Sutherland, got 18 tons to the acre from part of his 25 acres. David Hunter, of Sutherland, got an average of 18 tons to the acre from 45 acres. H. H. Hartman got 18 tons to the acre from 5 acres at Paxton.

I can not take time to give you the names of all the growers, so I have just given you samples from the different places. I will say that two-thirds of the growers in this territory raised from 12 to 25 tons to the acre; the balance from 4 to 12 tons.

Both the American and the Standard companies paid a flat rate of $5 per ton; and they weighed and tared the beets at the different loading stations, which gave much better satisfaction than paying on the sugar basis. The beets averaged about 16 per cent sugar.

I am glad to inform you that we have been able to get much better work done than last year, and that there is much enthusiasm in the sugar-beet growing among farmers. Where a good crop was not secured farmers can see and understand why, and, instead of getting disgusted with the crop and saying it is a "fake," they admit their mistake and are going to plant again and profit by their experience. For instance, some men imagined when they got Russians or others to do the hand work that the less they did themselves the farther ahead they would be. Consequently they would only plow about 3 inches deep, not half prepare the ground before planting, and cultivate as little as possible after beets came up. The result was that if they got enough to pay their help they did well.

After this year's experience, I wish to impress beet growers with the necessity of first plowing deep, then pulverizing the soil, then packing with a roller or some other

machine in order to get soil so it will hold moisture, and also to get an even stand of good healthy beets. It also enables cultivation as soon as beets are up (which can not be done without injury to the crop in loose ground), thus getting rid of weeds before they get a start. Then they should cultivate after each rain just as soon as the soil will permit. They should not be afraid to cultivate a little late if crop requires it, even if they do break a few leaves.

In this territory rows 18 inches apart, and beets 10 inches in the row, will, I believe, give best results. Some hurt their crop by having the beets too close, and others by leaving them too far apart. Three important things are, getting the land ready first, thinning out before the plants get too big, and cultivating properly. I believe growers, as a rule, do not attach enough importance to cultivation, especially where they employ hand labor; but I have known cultivation, other things being equal, to make a difference of 5 tons per acre in the crop this year. As regards the time of thinning, some farmers think just so they get the beets thinned it does not matter when; but the fact is, in the same field, under the same conditions, and planted at the same time, if one plot is thinned out when the plants have four or six leaves, and kept clean and well cultivated afterwards, while another plot is let go until the beets and weeds have almost closed the rows—which will not take long—and is then cleaned out and given good cultivation afterwards, the first plot will make nearly twice the tonnage and have a better sugar content.

My plan this year is to try to get those farmers to take hold that intend to get all there is in the crop; consequently, I am going to try to impress growers with the fact that there is more money in getting 20 tons per acre from 10 acres properly cared for, with ground selected and got ready the year before, than there is in 40 acres at 10 tons per acre done in a haphazard way.

The sugar-beet growing is in a very healthy condition in this valley, and I believe with the same success the coming year this valley will justify a 500-ton factory. The Republican Valley has grown about the same acreage as this, but I am unable to give you the results.

Very truly, yours, JAMES SCILLEY.

NORFOLK.—This factory experienced a normally successful year. It received a large supply of beets, and these were of good quality. There was considerable wet weather during the early stages of the crop—a great many other crops being drowned out entirely—but the principal damage to beets was the growth of weeds and grass. The stand of beets was very good. The crops yielded a fair average tonnage.

In general, it may be said the results were about as satisfactory this year as in any other of its fourteen years of experience.

NEW YORK.

LYONS.—New York has at present one factory, located at Lyons. It had the most successful year in its history. It had a campaign of one hundred days and over. The beets raised throughout the district averaged 9.38 tons to the acre. The sugar contents of the beets averaged 16 per cent; the purity, 85.

It is interesting to note the general improvement of conditions affecting this factory. It has had to overcome many things, but it appears to be now thoroughly established.

Under the reorganization and the new management this factory has become much more effective during the past season. It had considerably more contracts and a larger area planted to beets than ever before, approximately 5,500 acres.

Owing to snows and inclement weather farmers were late in their planting, very little of which was done earlier than May 1. The weather was unusually favorable throughout the growing season, and results were much more satisfactory than heretofore. The factory received the largest supply of beets in its history.

BINGHAMTON.—The factory formerly operated at this place finally succumbed on account of repeated failures to secure a sufficient supply of beets. It has been moved to Blackfoot, Idaho.

OHIO.

General improvement of conditions is quite noticeable throughout the State of Ohio.

FREMONT.—For several years this factory struggled along, unable to secure a competent supply of beets. The factory has now developed sufficient area to insure a larger supply. This season was the most successful of its history. It worked a campaign of one hundred days or over. The farmers secured an average of 9 tons of beets per acre. The average sugar contents of the beets during the campaign was 16 per cent; the purity, 84.

Conditions have been gradually improving at this place. The company has succeeded in making more contracts than in past years. Farmers previously growing beets, as a rule, increased their acreage. It contracted for approximately 5,000 acres of beets. Not all of this was planted; over 4,000 were harvested.

The company arranged for the colonization of Russian families to do the work in the beet fields.

December 19 the company entertained several hundred beet growers. There were marked indications of better feeling and understanding between the company and its beet producers than in former years. This concern seems to have finally reached a condition of stability insuring its permanent progress.

OREGON.

The sugar industry in the State of Oregon shared in the general prosperity of the industry. This season's results are the best since the establishment of the one factory, this result being largely due to the better methods of the farmers in beet growing.

The general average yield of beets per acre in Oregon was 8.4 tons; sugar in the beets, 15.3 per cent; purity, 85.5.

LA GRANDE.—Factory conditions are gradually improving at this place. Last season (1903) it had in about 1,800 acres of beets; this

season it secured approximately 3,000 acres. New sections are opening up to this production, and they exhibit more interest in the crop than those in the immediate vicinity of the factory.

The extra work in the beet fields was accomplished by importations of a large number of Japanese and Indians. The Indians were secured from the Umatilla Reservation and the Japs from Portland and towns along the western coast.

The factory ran sixty-five days, a much longer campaign than at any previous time in its history.

The sugar-beet culture is finding more favor with the farmers generally, but not to the extent it should. There are many reasons for this. One is that the country is exceptionally rich and produces ordinary crops with little attention, particularly small grain.

Here deep fall plowing is conducive to large tonnage of sugar beets. The frost improves the land, affording an excellent bed for seeding. On fall plowing, however, beets will generally be much shorter than on spring-plowed ground.

The best fertilizer is alfalfa, but as it requires two years to secure a good stand, this crop, for best results, should continue on the land that long. The agriculturist recommends for green manure planting wheat or oats quite thick, allowing them to grow from 2 to 3 feet high, and then disking them under. By hanging a heavy chain in front of the disk plow, every particle of green grain will be well covered, and the crop of beets next season will be much benefited.

The factory harvested about 2,500 acres this year. The tonnage was very good. It pays $4.50 per ton for beets at the factory. The prospects for 1905 indicate a largely increased acreage. It uses the Kleinwanzlebener seed mostly, but has made trials of some seed grown locally with excellent results. The soil is sandy and black loam. The sandy land is more easily worked, but the black loam brings the heaviest yield. Taking all in all, however, the sandy loam is preferred, for the reason that less dirt sticks to the beets; it can also be worked in wet weather, while the black loam becomes sticky and beet tools fail to scour.

UTAH.

This State now has four factories, located at Logan, Ogden, Lehi, and Garland. The first three have been operating for several years. It may be said that all have fully worked out and developed conditions insuring successful future operations. The three older factories had long campaigns, ranging from one hundred to one hundred and fifty days.

Arrangements have been made for establishing two other factories in this State, to be in operation next year.

The average results of these factories for the season are as follows:

The average acreage of the factories was 5,012.5 acres.
The average yield per acre was 12.12 tons of beets.
The factories worked an average of 60,750 tons of beets.
They produced in sugar an average of 14,180,150 pounds, or 7,090 short tons.
The sugar in beets averaged 14.77 per cent; the purity, 82.96.
The factories paid the farmers for beets approximately $1,215,000.

GARLAND.—This is the second year's operation of this factory. Its supply of beets was considerably greater than that of last year, and the general results were satisfactory to all. The town of Garland has been very much stimulated in a business way.

Outside the usual help on the farms, extra labor was supplied by a large colony of Japanese imported into the section, and an equal number of boys from Salt Lake City and the larger towns.

Many Japanese are hired in the Garland district. A number of these have rented about 500 acres of land for beet growing.

The Bear River Valley is one of the best in the United States for sugar-beet raising. It has a perfect irrigation system and excellent climatic conditions.

On account of the superior agricultural character of this district, the Utah Sugar Company is now producing there most of its beet seed, approximately 20,000 tons this year. The company has stored away about 150 tons of mothers at Garland, and 50 tons at Lehi, to be planted for seed production next year.

LEHI.—The season opened up quite favorable in this vicinity. A full supply of beets was early contracted, enabling the lands to be put in the proper condition at the proper time. The factory has fully and completely established itself.

During the season the slicing plant located at Bingham Junction was removed, to facilitate the beet-growing in the district known as Spanish Fork and other near-by localities. It appeared that this change would better meet the needs of the factory and accommodate more farmers producing beets. The location at Bingham Junction was too near Salt Lake City; the land could be utilized for other intensive purposes, particularly supplying products for the city market.

For eight years the company has been engaged in the production of home-grown seed. This seed ranks very high in quality in comparison with the seed imported from Europe, showing, as a rule, higher vitality and producing beets of a better quality. The plant has cooperated with the Department of Agriculture in the experiments to produce a race of beets bearing seeds each containing a single germ.

The results in beet growing were more favorable than in any other year in the history of the plant.

Mr. Thomas R. Cutler, general manager of the Utah Sugar Com-

pany, which owns two factories in Utah and two in Idaho, as to the conditions prevailing this year, makes the following report:

SALT LAKE CITY, *January 14, 1905.*

DEAR SIR: Our two factories belonging to the Utah Sugar Company are located at Garland and Lehi, Utah. The former factory was in operation fifty-nine days and the latter one hundred and one days.

The climatic conditions in Utah have been very favorable for beet culture.

Utah has been particularly happy in the fact that its farms are held in very small acreages, the average contract, perhaps, not being 7 acres to the farmer, and the farmers, having their own labor, are entirely independent.

The beet crop is more remunerative than any other product, and as the water for irrigation is becoming more expensive each year, the farmers find that it is necessary to utilize the water on such crops as will yield the largest revenue. At Garland the farmers are demonstrating from time to time that, on such lands as are suitable for raising beets, this crop brings them in more than grain or alfalfa, which have been the main crops during the past.

Experience has taught the farmers, both in Utah and Idaho, that it is very essential to select the choicest land for the beet crop, also land that can be uniformly irrigated, and to get the best results this crop must be looked after very carefully.

We have tried in Utah and Idaho almost all kinds of artificial fertilizers without any apparent beneficial results; but we have discovered that barnyard manure or clean alfalfa, plowed under, is very good. This gives the farmer good tonnage and does not impair the quality of the beets. We have demonstrated also in Utah that beet seed can be successfully raised on such lands. In Idaho as yet no beet seed has been grown.

The four-row beet-seed drill is far superior to what it was ten years ago. Also what is known as the two-row and four-row horse cultivator is a great labor-saving implement, and the new beet lifter or digger that has been largely introduced is a great improvement over the old-style beet plow.

We understand that some implements for topping and digging the beets have been used in some localities, but without any satisfactory results.

The number of contracting farmers at Garland was 250; at Lehi, 1,800. The number of acres harvested at Garland was 2,857; at Lehi, 9,200.

At Lehi and Garland the price for beets delivered in sheds is $4.75 per ton. Where they come in by car, the price varies from $4.25 to $4.50.

At Garland the acreage has been materially increased. At Lehi, at this date, the prospect is just as good as it was last season.

At all our places we have planted 75 per cent of the Original Kleinwanzlabener seed; the other 25 per cent is of Gabr. Dippe seed, with just enough of other kinds for experiments.

A sandy loam with clay subsoil is the best adapted in our localities. In many cases clay loam produces just as large a tonnage with satisfactory results as to sugar and purity, but the latter is not as easily prepared to receive the beet seed as the sandy loam, unless properly plowed in the fall.

The Lehi factory had a slicing station, as you know, at Bingham Junction, but last spring this station was removed to Spanish Fork, 27 miles south of the main plant at Lehi. The reasons for making this change was that we could not get sufficient water the latter part of the season for the operating of the plant at Bingham Junction; and again there were not enough beets delivered at that point by team to justify retaining this plant there; so it was moved, as stated above. At the new location we get about 3,000 acres of beets delivered by team.

Yours, very truly,

THOMAS R. CUTLER,
General Manager.

OGDEN.—The factory at this place has been very much improved by the installation of the Osmose process and by other recent improvements. It secured a larger acreage than usual, farmers generally increasing their amount of land devoted to beets.

The early season was quite favorable. There was plenty of water in the ground and a large deposit of snow upon the mountains upon which sufficient water for irrigation depends.

The spring was a little too cold and wet, but this was followed by better weather and generally good results in beet production. Prospects for the future are very encouraging.

LOGAN.—Weather conditions were unfavorable during the spring months in the farming districts supplying this factory with beets. Following the inclemency of the early season came insects doing damage to such an extent in places that farmers plowed up their beets, on the whole, considerably decreasing the area supplying the factory. As the season progressed it was much more favorable. The yield was considerably better than anticipated; especially the quality of the beets was higher than usual.

Though this factory has operated four years, it has never secured a supply of beets giving anything like a long campaign. Everything considered, this has been the most successful run in the history of the factory.

WASHINGTON.

General conditions throughout the beet-growing district of this State during the past season were not as favorable as those noted in most other beet-growing districts. The rainfall was slight. While the acreage secured by the factory was quite sufficient, the average yield was low. Comparing results in the beet fields with other crops, however, the situation seems much more encouraging, as cropping in the State was unfavorable generally during the season. Increased satisfaction seems to prevail among the farmers generally. Prospects appear fairly good for next season.

WAVERLY.—Conditions around this factory are gradually improving. Farmers are becoming more accustomed to beet culture and better advised as to its crop returns, one year compared with another.

This season was exceedingly dry, having less than half the usual precipitation from April 15 to November 1. The yield per acre was about 66 per cent of that of former seasons. No beets are grown under irrigation for the factory.

The beet crop is gradually growing in favor with farmers, because of better remuneration, as a rule, than that realized from other crops.

Barnyard manure is the principal fertilizer for beets, giving very satisfactory results. Its use increases with each successive season.

The factory pays for beets $5.25 per ton delivered in company's sheds

at Waverly. Present indications are favorable for an increase over last year's acreage.

The seed mostly used is original Kleinwanzlebener.

The soil is mostly black loam, on a yellow clay subsoil, with rolling surface. There is but little flat or level land in the beet-growing district. About 90 per cent of the cultivated area is rolling. The flat or level lands are too cold for sugar beets.

WISCONSIN.

Two sugar factories have been established in the State during the year. The machinery for the factory at Janesville was moved from Dresden, Canada, and that for the one at Chippewa Falls from Kalamazoo, Mich. For new concerns the results were very satisfactory, both to the farmer and the factory. The latter is under the management of the same parties who operate the factory at Menomonee Falls.

There has been more agitation in this State for the establishment of new factories than in any other section of the country. The factories in this State will be doubled in the near future. General conditions were quite favorable to beet growing.

A summary of average results for the year in Wisconsin is as follows:

The average acreage of the factories was 3,166 acres.
The average yield per acre was 11.37 tons of beets.
The factories worked an average of 36,000 tons of beets.
They produced in sugar an average of 7,866,666 pounds or 3,933 short tons.
The sugar in beets averaged 14.54 per cent; the purity, 83.51.
The sugar factories paid the farmers for beets, approximately, $540,000.

CHIPPEWA FALLS.—The season started in this locality with quite favorable indications. Before its installment the plant had placed contracts with the farmers for a full supply of beets for operating its first campaign. For a first planting the stand was good, and, generally speaking, the quality and yield of beets was very satisfactory.

The plant was shipped here from Kalamazoo, Mich., and reinstalled at this place. It was improved and enlarged, and with it was installed a pulp-drying plant. It is the purpose to produce a stock food from the by-products—pulp and molasses—similar to that produced at Janesville, Wis., and at Alma, Mich.

As to conditions and results this year, I publish below a report made by the agricultural manager, A. F. Postel, as follows:

CHIPPEWA FALLS, WIS., *January 12, 1905.*

DEAR SIR: Complying with your request of December 16, permit me to hand you the following information herewith:

The name of the company is the Chippewa Sugar Company. It was built in 1904.

The past season was wet and cold, and therefore not propitious for getting the best results in beet culture. Still, in spite of this, the results obtained were very satisfactory, taking into consideration that this is our first season. Potatoes rotted in the ground and corn did not become thoroughly ripe, so that crops were half failures.

Adding to this the prevailing low price for potatoes, it can be easily seen that the hardy and ever-sure beet crop with its fixed price is finding favor with the farmers. They have already prepared a larger acreage for beets in the fall.

We applied extensive subsoiling in the fall of land to be devoted to beet culture this season. Experiments with fertilizers have not been made, as this was our first season and the farmers were not inclined to go to any extra expense beyond what was absolutely necessary. Still we shall encourage such experiments the coming season again and hope to accomplish something along this line.

Four different kinds of seed were tried: Elite Kleinwanzlebener, C. Braune, Biendorf; Imperial Kleinwanzlebener, O. Hoerning, Volkstedt; Original Kleinwanzlebener, Rabbethge & Giesecke; American-grown, E. H. Morrison, Fairfield, Wash. The results obtained were overwhelmingly in favor of the Braune seed as regards tonnage and sugar percentage, so that this seed will be used almost exclusively the coming season.

The implements of recent design used by us were the following: Two-row beet and corn-drill combined; two-row beet cultivator; one-row beet lifter and subsoiler combined. These tools have given good results and can be recommended. The drill will plant either beet seed or corn, and has the further advantage that it will plant the necessary amount of seed per acre (18 pounds of seed in rows 20 inches apart); so that the farmer can not use less seed even if he wants to, unless he plants in rows 22 or 24 inches apart, in which case the stand in the row will be the same; i. e., a full one.

The number of beet growers who signed contracts was 1,600. The number of acres harvested was 3,000. We paid $4 per ton for beets containing 12 per cent or less of sugar, and 25 cents more for each per cent above this. The average price paid this year was $4.75 per ton, and 25 cents additional for beets delivered after November 1.

Clay loam and sandy loam are the best beet soils.

The farmers around here seem willing to learn, which can not always be said of the farmers in other localities. This is demonstrated by the fact that the majority of our beet growers this year not only manured, but also subsoiled, intended beet land in the fall. I regard subsoiling as absolutely essential to success in beet culture on the heavier soils, and for this reason I gave the growers around here a beet lifter which they could also use as a subsoiler. In this way I "killed two birds with one stone," and hope to see the spangle-rooted beet disappear entirely and have it replaced by the normally-grown beet with one long and smooth root, pleasing to the eye and the pocketbook of the beet grower and sugar manufacturer alike.

JANESVILLE.—The early season in this district was quite favorable to beet growing. The people are engaged in tobacco culture to a considerable extent. Some of the acreage hitherto devoted to this product was put in sugar beets for the first time this year. Altogether about 4,000 acres were contracted for the factory, some of this being in northern Illinois.

To considerable extent beets have been grown at this place for the factory at Menomonee Falls for the past three or four years. As the farmers were accustomed to tobacco production there has been considerable speculation as to the reception the tobacco growers would give the beet crop. The Milwaukee News, in discussing this point, gives the following figures:

The number of acres of beets planted in the county last year (1903) were 654; in tobacco during this period there were 7,372 acres. This year (1904) 3,380 acres were planted to beets, and only 4,900 to tobacco.

The season was quite favorable throughout; results of beet growing were quite generally satisfactory.

In addition to manufacturing sugar the factory has installed a pulp-drying plant. The wet pulp and waste molasses are mixed together and dried in this plant for stock food. This is an innovation in Wisconsin, but undoubtedly on account of the heavy stock interests of the State the stock food will find a ready market. For storing this product the plant has installed a large warehouse devoted exclusively to its use. The plant has done very satisfactory work taking care of the refuse pulp as it came to it from the factory.

This company adopted the innovation introduced at Menominee, Mich., last year. Invitations were sent out to 3,500 farmers to attend a barbecue to be held at the factory. A programme was arranged, including speeches by some of the leading business men and agriculturists of the State. This method brings the farmers in closer touch and is more effective in demonstrating their interests in the beet-sugar industry.

Last spring was cold, wet, and late, and there was six weeks' drought in July and August. There was excellent harvesting weather in the fall. The season as a whole was not a bad one for beets. Early in the spring plenty of rain fell, which gave good germination. Also late in the fall, September and the early part of October, there were very beneficial rains, which helped materially in enlarging the yield.

Beet growing is in favor with the farmers, although they do not go into it on a large scale, the average being about 2½ acres to each farm.

There were 1,350 contracting farmers, who harvested 3,250 acres. The prices paid for beets and the contract conditions are as follows:

The company agrees to pay for all suitable beets delivered under the contract $4.50 per ton (net weight) for beets averaging 14 per cent or less of sugar, and at the rate of 25 cents per ton for each additional 1 per cent of sugar contained in the beets.

The company agrees to pay an additional amount of 25 cents per ton for all beets delivered to its factory by wagon. In addition to the above the company agrees to pay 25 cents per ton for all beets delivered after November 1. Payments are to be made on the 15th of each month for beets delivered during the previous month.

All testing of beets shall be done in the labofatory of the company by a chemist appointed by Prof. W. A. Henry, director of the agricultural experiment station at Madison.

In the event of the factory of the company being destroyed by fire, or for any other reason incapacitated at any time previous to the delivery of the beet crop, the company shall have the option to pay the beet grower $5 per acre for all beets he may have under proper cultivation, allowing the grower to retain the crop.

The company guarantees a freight charge of 25 cents per ton in car lots of 15 tons minimum weight from all points within 50 miles of Janesville, Wis.

All car shipments shall be weighed by the Western Railway Weighing Association and settlement must be made on the basis of such weights.

There were approximately 36,000 tons of beets harvested.

The prospects for acreage for 1905 are very good. The factory anticipates contracts for at least 5,000 acres.

The seed used this season was the Hoerning variety.

The best results this year came from old tobacco ground. The soil conditions differ in the different localities. The principal soils are black sandy loam, a heavy black soil, a clay loam, and a clay mixed with black dirt and sand, with generally a good clay subsoil. The best results come from the sandy loam soil.

This part of Wisconsin is developing very rapidly in the beet-growing industry, and is certainly giving good results. The farmers have become more educated in the matter, and will naturally show more interest next year than this.

MENOMONEE FALLS.—It is estimated that fully 4,000 acres of beets were planted for this factory.

To the energy and intelligent systematic work of Mr. R. G. Wagner, manager of the factory at Menomonee Falls, is largely due the rise and healthful progress of the beet-sugar industry in that State. As to conditions and results in the factory districts he makes the following report:

MILWAUKEE, WIS., *January 7, 1905.*

DEAR SIR: I consider the past season as not the very best for sugar beets. The early summer months were very cold, while the month of September and the first half of October were cloudy and rainy. However, while this undoubtedly kept down the sugar content, which is averaging so far about 14.75 per cent, the tonnage is very good. Many farmers who have grown beets for us now for four years obtained 18 tons and more to the acre.

To get at the correct average of beets per acre is not practicable, owing to the fact that I do not know how many acres were planted or harvested. I have found that farmers are not very careful about planting the same acreage as contracted for. In fact, the farmer does not measure off his field—simply guesses at the contents; and I have frequently found that where a farmer has contracted for 5 acres and thinks he has 5 acres, he has not really 4; while, on the other hand, farmers who contract for 1 acre frequently plant 1½ acres. Based on the acreage contracted for, I believe our average tonnage to be about 12 tons.

The farmers in the vicinity of our factory are very much more favorably inclined toward beets than formerly, and have become satisfied that it is not only a profitable crop, but that it is a sure crop. Two years ago, when the potatoes rotted, owing to excessive moisture, beets on the same fields gave good results. We have spent much time and money to educate the farmers to take up beet culture, and we are pleased to state that our efforts have been successful, and we do not anticipate any more difficulty in securing a sufficient supply of beets.

In regard to fertilizer, we have made no experiments with them, except that we recommend barnyard manure to be applied in the fall.

The only labor-saving device that has been tried, and which I think is an improvement on the old method, is that of topping the beets before pulling them, by using a blade attached to a handle, similar to a hoe not bent. This seems to require less labor than the old method of throwing them in piles with the tops and then picking up each beet and cutting it with a knife. No new labor-saving implements have been tried in this district with any success.

We have about 1,800 contracting farmers, who, as near as we know, have harvested about 4,500 acres. We pay $4.75 for beets containing 14 per cent of sugar or less, and 25 cents for each additional per cent of sugar.

The prospects for 1905 are very good.

We have used altogether German seed, particularly Hoerning and Braune.

Our land is mostly clay loam. However, we have also had good results from sandy loam.

At the Chippewa Sugar Company's factory at Chippewa Falls, Wis., which is under my management, the results in securing beets were not very good this year. The reason for this is that it was their first year, and there was practically no fall preparation made for the crop.

It is my intention to thoroughly canvass that territory and to keep experienced agriculturists among the farmers all summer, and from known results where the beets had proper care I am satisfied that a good crop can be secured. I am also satisfied that the farmers in the northern part of Wisconsin will more readily take to beet culture, because they are much more in need of a good-paying crop than the farmers in the southern part of the State.

STATISTICS OF THE BEET-SUGAR INDUSTRY IN THE UNITED STATES FOR 1904.

The following tables give the general factory and farm results for 1904: (1) A table giving the total and average results by States; (2) a table giving the results by individual factories.

The statistics are presented in such a way as not to reveal the identity of the individual factories. The data in these tables were furnished me directly by the factories except in five instances, in which cases I have inserted careful estimates based on reliable information.

General factory and farm results for 1904, by States.

State.	Area harvested.	Average yield of beets per acre.	Beets worked.	Sugar manufactured.		Average sugar in beets.	Average purity coefficient of beets.	Average length of campaign.	Estimated average extraction of sugar.
				Pounds.	Tons.[a]				
	Acres.	*Tons.*[a]	*Tons.*[a]			*Per ct.*	*Per ct.*	*Days.*	*Per ct.*
California	32,801	12.01	395,452	93,311,900	46,655.95	15.74	81.13	79.5	12.5
Colorado	44,456	12.32	550,359	124,553,800	62,276.9	15.64	82.46	87.1	11.1
Idaho	7,700	9.81	75,500	17,596,300	8,798	14.88	83.52	48.3	12
Michigan	53,777	8.06	433,428	103,864,830	51,932.26	15.13	85.47	46.8	11.7
Nebraska	13,100	9.41	123,300	29,374,000	14,687	15.08	81.48	91	11.6
Utah	20,060	12.12	243,000	56,720,600	28,360.3	14.77	82.96	106.7	11.8
Wisconsin	9,500	11.37	108,000	23,600,000	11,800	14.54	83.51	88.6	10.9
Minnesota, New York, Ohio, Oregon, Washington	16,400	8.69	142,500	35,206,000	17,603	15.65	84.77	80	12.3
Total and average	197,784	10.47	2,071,539	484,226,430	242,113.41	15.33	83.09	78	11.74

[a] Tons of 2,000 pounds.

General factory and farm results, by individual factories, for 1904.

Number of factory.	Average yield of beets per acre.	Price of beets per ton.	Average sugar in beets.	Average purity coefficient of beets.	Length of campaign.	Estimated average extraction of sugar.
	Tons.[a]		*Per cent.*		*Days.*	*Per cent.*
1	12	$5.00	13	79	82	11.4
2	8.6	4.90	17.6	82	44	13
3[b]						
4[b]						
5[b]						
6	13.1	4.75	16.5	81.5	69	10.3
7	11.6	4.75	16	81.35	77	12.8
8	12	5.00	14.8	81	125	12
9	11.7	5.00	15.7	82.6	120	11
10	12.9	5.00	16.5	82	129	12
11	11.56	5.00	16.3	83	110	10.7
12	11.5	5.00	15.3	82.6	61	11
13	12.5	5.00	16	82.5	75	11
14	13.42	5.00	15	83	91	11
15	9.11	5.00	15.1	82.4	45	10.5
16	13.76	5.00	15	82	81	10.5
17	12.19	5.00	15.2	82.3	72	12.2
18	10.67	c 4.50	14.65	83	58	12.4
19	10	c 4.50	14.5	83	62	10.8
20	7.94	c 4.50	16.3	85.9	25	12.9
21	8	c 4.50	15.6	86	47	12.5
22[b]						
23	8.1	c 4.50	14.9	86.38	30	10
24	7.83	c 4.50	15	84	39	10.5
25	9	c 4.50	14.5	84.16	60	11.1
26	9	c 4.50	16	84	77	14
27	8.09	c 4.50	14.5	85	25	10.9
28	7.05	c 4.50	15.43	85	31	11.9
29	7.36	4.75	14.57	86	53	13
30[b]						
31[b]						
32	7.68	c 4.50	13.10	84	28	11.3
33	7.02	c 4.50	15.7	85	75	13
34	8.86	c 4.50	15.5	86	60	13
35	9.48	c 4.50	16	89	91	11.8
36	8	4.75	14.13	84.8	29	11.3
37	4.92	c 4.50	15.4	84	11	11.9
38	7.28	c 4.50	15.6	85.6	43	11.7
39	8.82	c 4.50	14.5	83	50	10
40	12.32	4.75	15.6	86	98	11.6
41	10.72	c 4.50	15.2	83	90	10.5
42	8.4	c 4.50	14.7	80	67	11
43	9	5.00	15.17	80.89	116	13.4
44	9.38	5.00	16	85	75	12.3
45	9	c 4.50	16	84	102	13.1
46	8.4	c 4.50	15.3	85.5	64	12.5
47	13.16	c 4.50	14	81.5	119	12
48	13	c 4.50	14.3	82.1	148	12
49	11.75	c 4.50	15	84	101	11.3
50	10.71	c 4.50	16	83	59	12
51	5.38	5.25	15	83	60	12
52	11.78	4.75	14.7	83	106	10.9
53	12	c 4.50	14	84	115	11
54	9.5	4.75	15.1	84	45	10.9
Average	10.47	.....	15.33	83.09	78	11.74

[a] Tons of 2,000 pounds.
[b] Not operated in 1904.
[c] Price paid for beets reaching a minimum standard of sugar content and purity. For each additional per cent of sugar an additional amount per ton (in some cases 25 cents, in others 33⅓ cents) is allowed.

JUVENILE COURT WORK IN COLORADO.

Throughout my report I have often referred to the availability for work in the beet field of the unemployed in our cities and towns, and I have laid special stress on the employment of children for this work during school vacations.

Several of the States have established juvenile courts with special jurisdiction over minors and their infractions of law. The functions of these courts are broad, the general idea being to reform and help youthful offenders. The coldness and rigidity of ordinary penal administration is largely eliminated. It is recognized that idleness is the main cause of youthful crime and at the same time the principal factor in developing mature hardened criminals. Young people must be kept busy, both in self-improvement and self-sustenance. Employment is the antidote to idleness and crime.

Probably in no place in the country has juvenile court work advanced so rapidly and thoroughly as in Denver, Colo. This is due largely to the enthusiastic and systematic work of its instigator, Judge Ben B. Lindsey, of that place.

For employment of the young people coming under its jurisdiction the court naturally turns to the beet fields of the State. This work is especially adapted to young people from nine to seventeen years of age. It may be said that youths of this age in the beet fields are of more service than adults in doing the weeding, thinning, and similar hand work. They are more nimble, and therefore more useful. This work comes at a time when public schools are closed.

In beet growing up to the present, the Denver court has confined its attention largely to boys. Squads of about 20 are sent out to the beet fields under the direction of a "probation" officer of the court, who makes the contract with the farmers and all arrangements for the maintenance of the camp, lays down the rules governing deportment and executes the same, collects the money for the boys' labor, keeps the accounts, pays the bills, and distributes the earnings. Usually contracts are made with the farmers at so much per acre. Since a boy can accomplish as much as an ordinary adult laborer, he receives as much.

There is no other kind of work so specially adapted to the needs of the juvenile court, and it is developing a great resource of labor for beet fields. Our large cities contain many young people to whom this sort of work is well suited, and the opportunity to do it is a boon, not only to the wards of the juvenile court, but many others for whom employment is just as necessary.

Plate IV (figs. 1 and 2) graphically portrays the character of the work developing in Colorado under the administration of the juvenile court. The court is ably assisted by the Juvenile Improvement Asso-

ciation, description of which I clip from the court's pamphlet, "The problem of the children, and how the State cares for them," as follows:

As an auxiliary to the work of the juvenile court, a number of our best citizens have formed the Juvenile Improvement Association, of Denver. The purpose of this organization is to encourage social betterment for children. The plan was proposed about a year ago and has met with much favor.

In response to my communication asking for plans and details of conducting this work, Judge Lindsey writes as follows:

In the first place I deeply appreciate the interest you show in this matter and the spirit of your letter. I have not received the report you speak of, but shall look forward to its receipt with a great deal of interest.

A gentleman from the northern beet fields was in to see us to-day, and he declares that if proper arrangements can be devised 500 Denver boys can be kept at work most of the time between June and September by his company alone.

. Briefly, our plan was to send fifteen or twenty boys in company with a probation officer and a cook with a complete camp outfit. The camp was pitched in different fields from time to time. In this way the probation officer looked after the boys and saw that they did their work and at the same time had a good time. Supposing a teacher in a school should go out of the room and leave the best average boys of the best families, how much would she get out of them? It is the same way with these boys in the fields. If you have some one with them, just as a teacher in a school, you will get good work out of them. We started last spring by having the boys come to my court once every two or three weeks, when we would talk to them upon the importance of the work, explain the beet-sugar industry and the responsibility that rested upon them to do their work well. In this way we endeavored to get the most responsible juvenile labor. The results accomplished were most satisfactory, and a number of families left the slums of Denver and became residents of the beet-field districts, because it was brought to their attention in this way through their boys working in the fields. The first year we attempted this work it was without organization. The boys were simply sent alone and very few of them did well. In fact, it was declared a failure by the farmers. The last year we had fair success with, I should say, one-half of the boys sent out.

I send you, under separate cover, a little booklet called "The Problem of the Children," and on pages 129 to 132, inclusive, you will find a statement regarding this work.

I wish to thank you for your interest in this matter, as I believe it contains the germ of a wonderful work which can be done by the city and the country cooperating together for the help of our city boys. Of course it is going to require time and care to perfect a plan that is satisfactory, but that it can be perfected I have absolutely no doubt.

Descriptive of the purposes, methods, and results in the beet fields, I clip from the court's pamphlet, referred to above, the following:

WORK IN THE BEET FIELDS.

Among the things which the society proposes is to take advantage of the opportunity in the northern and southern sugar-beet fields to supply city boys with work during the summer. Average boys will not work in school unless the teacher is present. Neither are they likely to work in the fields unless some capable person is there to encourage and direct them. It is not surprising, therefore, that boys heretofore sent to the beet fields without organization or discipline did not give general satisfaction. It is now proposed to send a probation officer in charge of each 20

FIG. 1.—A SQUAD OF JUVENILE COURT BOYS IN A COLORADO BEET FIELD.

FIG. 2.—THE SAME BOYS AT WORK UNDER AN OFFICER.

boys, with a complete camp outfit, which is to be pitched in the most favorable place near the fields. A number of such camps have been organized and at the present writing are being sent to the fields, with every prospect of success. These boys have been meeting faithfully with the judge and probation officers in the juvenile court upon designated evenings, when their work and its importance—not only to the farmer, but to themselves, to the court, and to the improvement association—is freely discussed. The boys are thus made to feel their responsibility, and, while we can not tell what success may be had or what we can do until we try, we are looking forward with much interest to the result of this plan. Last year something over 100 boys were sent to the beet fields from Denver. They were allowed to do very much as they pleased, and with the same results as would happen in any well-regulated school of the best boys. Less than one-half of them gave satisfaction. Yet something over 20 families went from the slums to the beet fields because of the experiment, and notwithstanding its disappointments, we account it to have been more than worth while.

The court is under great obligations to Mrs. J. J. Brown and her able assistants, Mrs. Margaret Fealy, Mrs. Alexander Helme, and the young ladies who assisted them in the entertainment given at the Broadway Theater in April, 1904, for raising funds for this association and the promotion of the beet-sugar work. The beet-sugar industry in Colorado is assuming enormous proportions and demands a class of work in the fields for three months in the summer—June to September, vacation months—which can be well performed by boys under proper discipline. We are simply trying to avail ourselves of these opportunities for the good of the boys.

GROWING SUGAR BEETS.

In my last annual report (for 1903) I included a carefully revised description of the most approved methods of growing sugar beets. As the edition of that report is now practically exhausted, I have decided to insert here the matter referred to for the benefit of farmers who are taking up sugar-beet growing for the first time.

SELECTION OF THE SOIL.

The first requisite in successful sugar-beet growing is a suitable soil. This will become more evident to the farmer as he proceeds with the crop. There is no doubt that the beet crop makes a heavy draft upon the soil, and should be classed in this respect with corn, potatoes, and tobacco. It quite often happens that the farmer selects a piece of ground for growing sugar beets not well adapted to growing other crops, and not considered productive. If a soil is light and sandy it should be avoided for the beet crop, unless, through rotation of crops and fertilization, it has been brought up to the right condition for sustaining such crops as corn and potatoes.

I am often asked the question, "Do sugar beets exhaust the soil?" The proper answer to this question is that any crop will exhaust the soil if planted continuously and nothing is done to renew it. Sugar beets will not exhaust the soil more than other heavy crops if the right methods are pursued. It should be the aim of every farmer growing sugar beets to make a profit out of them, the same as any other crop; therefore he should be careful in the selection of land for growing them. If a piece of land is not adapted to general cropping, avoid it for sugar beets. Put upon it something better adapted to it, and operate, if possible, in such a way as to make it productive. If it is wet and sour, drain it. If light, put it in grass or build it up with legumes in rotation with light crops and liberal applications of barnyard manure. At least do not try to reclaim it with sugar beets. They are not a good reclaimer.

Beets are an expensive crop at the best and should be put upon lands offering the

best opportunities for good yields. It takes 6 to 7 tons of sugar beets per acre to pay the actual cost of production, and it is the tonnage of beets over and above this amount that yields the profit. So it can readily be seen that poor land should be planted to something whose production is not so expensive. On poor land sugar beets are liable to produce a loss, either through low sugar content and purity or small tonnage of beets per acre.

A prospective sugar-beet farmer has a great many facilities at the present time for posting himself in this respect. Sugar-beet growing is becoming quite general throughout the various parts of the United States, and it is quite probable that he can find some one in his neighborhood who has practical knowledge of the subject. If not, the factories are constantly publishing literature containing directions for growing beets, selection of the land, and treatment after the beets are planted. The experiment stations of the various States are publishing bulletins and distributing them free of charge, containing much matter upon these subjects. Every factory has an agriculturist for the express purpose of instructing the farmers in the proper methods of growing sugar beets, the selection of lands, and how to treat the different lands in growing this crop. The Department of Agriculture is publishing a great deal of material upon the subject of the beet-sugar industry. All of these publications are available and free for the information of the farmer engaged in sugar-beet growing.

Most farms contain different kinds of soil, which are in different states of availability for cropping, though some of them are equally good in all parts. The land selected for sugar beets must be fertile and susceptible to fine pulverization. The surface and subsoils must be of such a nature as to be easily penetrated by the taproots, laterals, and rootlets.

The land should be as free as possible from the seeds of weeds and grass. However, these can be overcome by sufficient attention and labor.

PREPARING THE LAND FOR THE SEED.

Preparing the soil properly for growing sugar beets is another important feature and comes next to the selection of the soil itself. We must consider all the different important steps necessary in growing a beet crop. A failure in any one of them or a lax or loose method may result in disaster or loss. Having determined to grow the crop, no pains should be spared in doing it right. Everything depends upon doing each part thoroughly and faithfully. The preparation of the seed bed proceeds differently under different conditions of soil and climate.

There are two things, however, that apply generally: (1) Deep plowing and (2) minute pulverization by surface harrowing. Often it is necessary to subsoil while turning the land with a stirring plow. I have seen many instances where this has not appeared beneficial, many instances where it has appeared to be actually harmful, and many more where it has been absolutely necessary. Where winter freezing obtains, fall plowing is usually preferable, if possible. In the first place it catches the summer and fall crop of weeds and grass and turns them under, thus eliminating some of the difficulties of cultivation during the growing of the plants. In the next place fall rains or irrigation dampen the soil, and the upheaval through freezing mellows it and makes available certain of its elements of fertility.

After the land is plowed it should be thoroughly pulverized. This may be accomplished in several ways—by harrowing, dragging, planking, and rolling. Whatever local system is used most successfully in accomplishing this purpose is the most desirable. The idea is to pulverize the soil, and this is an important matter. The sugar beet is, in its early stages, a tender plant, and, while the soil should be fine, at the same time it should be moist and in such a condition as to be thoroughly compact about the beet ball, filling in the convolutions of its outer parts. This is desir-

able because it enables the ball to absorb moisture, which promotes the germination of the seed. If the surface is left in a lumpy or cloddy condition, many of the balls remain in open spaces, allowing free circulation of the air, and, instead of being moistened, they are dried up and the germs are killed.

Sugar-beet growing is garden culture on a large scale. It might be stated in a general way that, in preparing seed beds for such a crop, and in the care necessary to germinate the seeds and sustain the plants in their after growth, whatever is applicable in gardening will apply also to sugar beets. Most of the success of this plant during its growing season will depend upon the proper condition of the ground at the time of planting.

PLANTING AND GERMINATION.

The soil being in just the right condition and containing sufficient moisture to germinate the plant, the seed should be sown with a beet seeder in rows which are 16 to 20 inches apart, the distance depending on local circumstances and kinds of soil. It is better to use a specially designed beet seeder which is adjustable as regards width of rows and the amount of seed used per acre. The amount of seed usually required is 15 to 20 pounds per acre. The seeds are sown quite thick, the regulation of the amount per acre being governed by the proximity of the seeds in the row.

It is usually anticipated that many more seeds will germinate and come up than are required. This is the insurance part of the performance. A stand of beets is absolutely essential to the success of the crop. The beet seeder can be adjusted so as to plant seeds from a half inch to an inch and a half in depth, according to the kind of soil and its condition as regards moisture, warmth, etc. Care should be taken not to plant too deep. Until experience shall have given him a definite idea of his own, the grower should seek advice regarding the proper depth from some person better posted than himself as to planting sugar beets in his locality.

Some method of compacting the soil around the seed is generally desirable. This is usually accomplished by rolling. The smooth surface left by a roller is objectionable in some localities, for instance, where the soil is sandy and there is much wind, thus drifting the sand against the young beets, cutting them off or injuring them. Under such circumstances the ground is usually "planked." This is accomplished by drawing a platform arrangement made of planks over the soil, which leaves the surface considerably rougher than does the roller.

Care must be used to plant at the right time, the same as with any other crop. This must be determined by the moisture in the soil, its temperature, and the weather.

In from seven to ten days, if the soil is warm and moist enough, the beets will begin to make their appearance. The real struggle on the part of the grower for a crop begins at this juncture. There are several kinds of emergencies that may arise at this tender stage of the plant; a frost or a hailstorm can do them considerable damage, and they may have to be replanted. In replanting, it is not good practice to undertake to reset beets extensively.

This germinating period is the anxious time of the beet grower; a beating rain may crust the surface to such an extent that the beets can not penetrate it. In such cases I have seen valuable results produced by using a harrow to break up the crust of the surface. At every stage of the crop the beets must be kept clean and cultivation must begin at the earliest possible moment. Sometimes they are cultivated soon after planting. These first cultivations are accomplished with special beet cultivators, which work several rows at a time. These cultivators are adjustable to the width of the rows, and usually have, for the first cultivation, small, loose, sharp knives running parallel with the surface and designed to cut off the grass and weeds just below the surface.

BUNCHING AND THINNING.

About the time when the beets show the fourth leaf the bunching and thinning process begins. This is necessary to remove the excess of plants, made necessary in order to secure a stand of beets. Single plants should be left in the row from 6 to 10 inches apart, depending on the distance between the rows and the kind of soil. The time of thinning is important. If the proper amount of seed has been used there will be a considerable excess of plants, due to the nearness of the seeds to one another. A still further excess results from the fact that each particular seed ball contains from one to seven germs, all of which are liable to germinate.

It is quite evident that if all the germs grow, we are liable to have a bunch of several plants from a single seed ball standing very close together, often intertwining and forming a network of rootlets. The longer these plants are allowed to grow in this way the more complex, difficult, and harmful becomes the process of removing the superfluous plants. If this thinning is put off too long it disturbs the position of the plants which are to remain, breaks their tender rootlets, and materially and permanently injures them. Every effort should be made to accomplish this thinning as quickly as possible. A little money spent at this stage proves a very valuable investment in the after stages of the plant. A beet grower should prepare himself beforehand and be ready to accomplish this work and not allow it to drag along. With the best of intentions and preparations, he is liable to be more or less hampered by rains and other difficulties, but he should not fail to exert his best efforts to get his crop thinned as soon as possible after sufficiently matured for this purpose.

The process is known in the common parlance of the grower as "blocking and thinning." Blocking is accomplished by a person walking along the row with a short-handled hoe, sharp and of sufficient width, cutting out part of the beets so as to leave bunches the proper distance apart for the plants in the row. Thinning is accomplished by a person creeping along on his hands and knees and, with deft movements of the hands and fingers, removing all the plants in the bunch except the one his eye selects as the strongest plant. This all requires agility, attention, and industrious and laborious effort; it is in a sense a kind of cultivation, because all the soil is loosened around the plant, and should be compressed around it again with the hand before going on. Grass or weeds growing around the plants should also be removed.

CULTIVATION.

The methods of cultivation are various. The object sought is the elimination of the grass and weeds, the conservation of moisture, and the loosening of the soil around the plant. Beets must be kept clean. By this term in sugar-beet growing is meant more than in corn growing. It is desired that these beets shall be rich in sugar. The sun and air are the great reagents which accomplish this result in the beets. Weeds and grass must be eliminated from the crop in order that this may be accomplished. Beets are a vigorous crop, and they should have the full sustaining power of the soil and not divide it with waste plants and weeds.

After the first cultivation the horizontal blades of the cultivator are replaced with elliptical blades which penetrate the soil 3 to 4 inches and loosen it, making a dust mulch which conserves the moisture of the soil and promotes the growth of the plant. The cultivator is usually drawn by a single horse or mule, and is manipulated by a single laborer, who usually cultivates two or four rows at a time.

It can be seen that this part of the work is not particularly laborious. One man and one horse can cultivate many acres of beets in the course of the season. The number of cultivations given to a crop varies according to the exigencies of the case.

If it is a dry season cultivation should be continuous in order to maintain a dust mulch and conserve the moisture. If the beets are excessively weedy, hand hoes should be used. The number of times beets should be hoed also varies. The crop should be kept absolutely free of weeds; the ground should be kept soft and in good condition. If the land has become foul, the more hoeing the better the results. If the land is fairly clean but little hoeing will be necessary.

It has never been my privilege to visit Germany or other beet-producing countries, but I have been very much interested in interviewing well-informed agriculturists of our own country who have inspected the methods used in the beet fields of Germany, France, and other European countries and compared them with those prevalent here. It seems that there is a wide difference between methods of beet culture employed there and those employed in this country, and the difference is not in our favor. In Germany a plan is outlined for rotation, which involves the manipulation of the land for a series of years. This land is handled in such a way as to bring about the best results during the different years in the cycle of rotation and for the different cycles planned. There cultivation and preparation of beet fields are more like careful gardening. I grant that this involves some expense. The increased yield, however, and the economy of soil manipulation, induced by its better mechanical condition, very much overbalance the expense.

The cultivation of a beet crop should begin the moment the soil is broken up for planting to beets. If the land is broken in the fall it should be harrowed immediately, possibly rolled. It should be allowed to rest for a while, giving the weed seed time to germinate and come up, then it should be cultivated and harrowed again. In the spring after stirring it should be cultivated and harrowed several times until ready for planting. After planting it should be gone over with a "weeder" or harrow as soon as the weeds and grass begin to appear. These harrowings, etc., kill weeds, conserve moisture, and prevent the soil from baking. A cultivator should be brought into requisition at the earliest possible moment and the services of the "weeder" or harrow continued alternately with the cultivator even after the plants are up. Cultivation should be continuous from the moment the beets come in sight until they become so large that it is impossible to continue.

Good results are just as effective in teaching a farmer as in any other business. When doing things a certain way results in large profits, the farmer is disposed to repeat the operation. In order to procure a good crop of corn, potatoes, or any other cultivated field crop, it is not really necessary that the fields should be absolutely clean. They may be well cultivated and kept ordinarily clean during the growing season, and still a good yield may be secured. But yield is not the only thing under consideration with sugar beets; they must be pure, and high in sugar, and clean cultivation is vitally necessary in securing this end.

These other crops, although producing good yields, offer opportunities for the ripening of considerable weed and grass seed to trouble the farmer in the cultivation of his succeeding crops. When the growing of sugar beets proceeds in the correct way the ground is left practically free from these weed and grass seeds. When the harvester plows out the beets in the fall it is equivalent to another stirring of the ground. Whatever weed and grass seeds remain are turned under, and either germinate in the fall or come up in the early spring and are caught by the stirring plow or the early cultivator of the succeeding crop. If the crop of corn or potatoes follows in the spring, we have a mellow clean field, and the cultivation is very much facilitated. Just as beneficial effects result from having a clean field if wheat, barley, or oats follows beets. The influence of beet growing upon any other crop for the next two or three years is very decided. By the time this effect begins to diminish the cycle of rotation has run out and we plant beets again, and the crop can now be produced with better results and with less effort than before.

Farmers are not slow to learn the lesson taught by growing sugar beets. A mistake often proves expensive. A valuable fact learned through experience is sure to perpetuate its influence.

I grant that, to the average American farmer, accustomed to growing 160 acres of wheat or small grain, in addition to a large acreage of corn, such an outline of work as this may seem preposterous. I wish to assure any such person that it is the most logical method conceivable. This assertion will be indorsed by many successful beet growers of this country who are accustomed to beet growing in this or a similar manner. The logic of this method is that the yield and superior quality of the beets will pay all this expense and greatly enhance the profits besides. It must be within the experience of every observing farmer that a good stand of any crop is the first requisite of profit at the harvest. Such a stand depends largely upon a proper preparation of the seed bed. It must be just as patent to him that cultivation with a harrow and cultivator is a great deal cheaper than cultivation with the hoe or by any hand method. It is much easier and cheaper to destroy weeds when they first germinate or while they are young than it is after they have become well established in the soil. It is less expensive to cultivate in the manner above described than in the one ordinarily used, which involves hoeing and hand weeding.

To the person accustomed to his 160 acres this method of cultivation may seem impossible, but I contend that he should not plant 160 acres in sugar beets unless he has a large capital and plenty of labor at hand. For an ordinary farmer 10 acres is considerable. For an extensive farmer 25 acres is a large tract of beets. There are farmers who can successfully grow much more. The acreage should be such that it can be gone over many times with the rollers, cultivators, and harrows. If proper attention is given at the right time and is continuous, weeds can be kept in subjection with very little use of the hoe or hand work. Cultivation of other crops should teach this. Good judgment and carefully matured plans for the accomplishment of these things in the right way at the proper time is of vital importance. When such judgment and such planning are contributed beet growing resolves itself into a task of comparatively easy execution. If the farmer will use these methods and thin his beets at the proper time before they have become too large there can be no question of a good yield. Good judgment is also required in selecting the proper time for planting, when the soil is moist enough and warm enough to thoroughly germinate the seed.

Information and advice on all of these points can be obtained from the agricultural superintendents of the sugar factories. The farmer should not follow his own judgment and then hold the sugar factory responsible for poor results afterwards. His own judgment will be a good guide for him after he has had considerable experience in growing the beets, the same as with other crops. It will then be worth as much to him as anybody else's judgment, if not more, because he will understand better the action of his soil with beets after its manipulation for a series of years. Until such a time arrives he is bound to follow the advice of those especially provided by the factory for that purpose. In fact, as a rule, he should always secure the benefit of the advice and judgment of these factory experts.

When the leaves of the beets touch those of the adjoining rows their shade becomes so dense that the ground ceases to dry out so quickly and the weeds and grasses are overcome and smothered in the race for existence. Too much insistence can not be made on horse cultivation. Often growers stop cultivation at the critical time for its use, claiming the soil is too dry for cultivation. This is the time when it is most necessary. In fact cultivation should be constant. Killing weeds is not the only object; conservation of moisture is paramount when the season is dry. Cultivators stir the surface much deeper and more regularly than hoeing.

Constant cultivation maintains a dust mulch and breaks up and covers the sources

of egress of the moisture, thus holding it in the soil for the plants. Hand hoeing in its place is desirable, but my observations have convinced me that in practice in this country it is unwise and tends to a high cost of production. A proper system of horse cultivation will lead to better results and at a lower cost. No hand hoeing can ever take the place of the cultivator in conserving moisture. I believe that a proper system of cultivation would greatly cheapen the cost of production of beets and greatly increase the tonnage per acre. In fact, I have seen this demonstrated so often on the farms of our successful growers that I am convinced that to unwise and expensive cultivation is due most of the discouragement in sugar-beet growing wherever it exists. I can state it as a general rule that our best yields are not accomplished with the highest cost of production. It is common to see yields averaging 15 to 18 tons per acre in fields alongside of which are others yielding only 5 or 6 tons, the beets being grown from the same seed on the same land, but operated by a different farmer.

HARVESTING.

After the crops have matured the next work of the grower is the harvesting. The time of harvest is usually indicated by the agriculturists of the sugar factory for which the beets are destined, and notice is given to the grower to deliver his beets to the factory. An expert in sugar-beet growing can readily discern when beets are ripe. The leaves droop and take on a yellow cast. The sooner they are harvested after this the better, as they have reached their maximum of sugar content and purity. Warm fall rains are liable to start a new growth of the beets, causing them to send out a fresh supply of rootlets. This has a tendency to lower the purity and sugar content of the beets. If it is apparent that the crop can not be received at the factory at some time in the near future, the beets should be harvested and siloed. The contract usually provides for following the orders of the factory in this respect, and this is the safest course.

Siloing is performed by taking the beets after they are harvested and placing them in piles, covering them with dirt to prevent evaporation and freezing, and increasing the dirt covering as the weather grows colder. There are many methods of siloing in use. The usual one consists of piling the beets in long ricks, pyramidal in shape, with a base of about 6 feet and a height of about 4½ feet. If straw, beet leaves, old hay, or anything of the kind is used, it should be placed on the rick after the dirt. If it is placed on the beets before the dirt, it is liable, by the pressure of the dirt, to adhere to the beets. When they reach the factory this litter interferes with the further manipulation of the beets; it clogs the ditches, and some of it still adheres to the beets after they are washed and interferes with the slicing. For several reasons it is undesirable to place straw, beet leaves, or the like on the beets first.

There are many kinds of harvesters in use. A very common kind is a long-shanked plow, similar to a stirring plow, with a long, slender share which cuts off the beets about 9 or 10 inches below the surface, and the moldboard throws them over on their side, after which they are picked up. Another very common variety of harvester is an implement in the shape of a plow. Instead of a moldboard it has two shanks, each terminating with a prong like a finger. These are forced through the soil, one on each side of the row of beets, at a depth of about 9 to 10 inches. The opening between the two fingers gradually lessens as the beets pass through the space between them until finally the taproots are broken and the beets are lifted 2 or 3 inches from their position in the soil, whence they are easily extracted by a person following the plow.

Topping is a feature of harvesting which consists in removing the crown and leaves of the beet by a single stroke of a knife in the hands of the operator. It is the purpose of this operator to cleave the beet at the sun line, indicated by the discoloring

of that part of the beet just above the surface of the soil. After the beets are topped they are thrown into piles or in wagons or are sacked, preparatory to their delivery to the factory.

The delivery of the beets is accomplished in several ways. Anywhere within a radius of 10 miles from the factory they can be delivered in wagons. A greater distance than this usually necessitates delivery by railroads. There are different methods of unloading the beets, some special method of dumping being usually employed. This is accomplished in some places by dumps at the factory, on which the wagons are driven and attached, and, the horses being detached, the whole load of beets is then dumped into the bins automatically. At other times the wagons are prepared with nets lining the boxes. These are taken up by movable derricks or cranes and swung over the bins, where the nets open and the beets are dropped into the bins. In other places the beets are shoveled out of the wagons in the old-fashioned way with potato shovels or beet shovels.

At other places, where the beet-sugar acreage is grown in different localities, at a distance from the factory, special dumps are built near a sidetrack of a railroad at some point in each locality convenient for the surrounding farming district. Such a dump is elevated and approached by a long incline or tramway, at the lower end of which the beets are weighed and up which the load is driven onto the dumping platform. The horses are detached, and by means of the dump the whole load is precipitated into a car on the sidetrack below.. These are very convenient contrivances, and are becoming quite popular in a great many places. They offer convenience in the delivery of beets by the farmer, greatly lessening the cost of delivery and very much extending the beet-growing area of the factory.

CROP ROTATION AND GREEN MANURING.

A system of crop rotation should be adopted. The best rotation, as a rule, is the one which permits of fall plowing prior to the season of planting beets. This is especially true in sections of the country where the soil is subject to freezing. The proper rotation, however, depends entirely upon the location of the farm and the kinds of crops generally produced in that section.

I have seen sugar beets grown successfully and successively for a series of years, sometimes as high as five, but it goes without saying that this is not the proper method. Usually the results of such farming are bad. It should be the aim of the farmer to thoroughly fertilize the ground during the cycle of rotation. This is usually considered most favorable for beets if done a year or two prior to planting of the crop. Always start with the best land, and bring other lands up to a better state through rotation, cultivation, and fertilization before planting to beets. In this way beets eventually increase the productiveness of the whole farm.

I do not advise that the farmer should abandon other crops to grow beets; in fact, under a proper theory of farming, such a thing would be impossible. I do advocate, however, that a farmer should grow beets for two purposes. First, to improve his farm for other crops, and second, for the good profit in producing them. This simply involves the introduction of beets in rotation with other crops. Every farmer should have a plan for the manipulation of his farm for several years in advance. He should balance his stock interests with his crop returns. He is accustomed to growing certain staple crops adapted to his locality. He has done so for some time. He will continue to do so in the future. But there is no reason why he should not broaden his plan, if he has an opportunity to introduce a new crop which will increase his profits and his land. If a sugar factory is located in his vicinity, sugar beets should be introduced into the crop rotation. Probably the main crops have been hay, small grain, corn, etc. In a proper rotation with beets, these follow each other in a logical

manner from field to field. If the farmer has properly balanced stock raising against his crop production, he will be able to retire from the business of selling grain to that of feeding his stock for beef, pork, poultry, butter, cheese, and eggs. This enables him to improve his soil with barnyard manure; in addition, it enables him to introduce into the rotation the growing of leguminous plants, the clovers, stock peas, alfalfa, etc. These legumes store in the soils nitrogenous elements required by the grains, and thus serve as a valuable fertilizer. There are places where plowing under of this green crop is not practicable, but it is very desirable in most of the States where beets are grown under rain conditions and where the lands receive considerable freezing in the winter. Such methods as these are within the reach of almost every farmer growing beets and should come more generally into use than at present. The sugar beet should not be the rival of other crops, but should be their ally. We need more careful attention to systematic rotation and fertilization.

OTHER MEANS AND METHODS OF INCREASING SOIL FERTILITY.

Methods of fertilizing the soil for the beet crops are largely on trial in this country. That some fertilization is desirable goes without question, but in practice very little fertilizer is used. It seems necessary, therefore, to emphasize this question here. We have been so accustomed to growing all kinds of crops without fertilizers, reclaiming wild lands and continuing them in cultivation and cropping without any reenforcement, that this question has not come home to us as seriously as it has to the people of older countries. Even if we possess abundant virgin fertility in our best lands it will only be temporary at most; we are simply drawing on the future. The sooner we begin some systematic system of fertilizing the better it will be for the soil.

One of the fixed charges of cropping in the old countries, especially in the sugar-beet districts, is for fertilizers. In Germany sugar beets are grown on land worth from $200 to $800 per acre. In a cycle of rotation it costs to fertilize the land from $12 to $25 per acre. Crop earnings there have to be distributed upon such high values of land and fertilization that the people of this country possess a real advantage in this respect in the growing of sugar beets in competition with the farmers of those old countries. A sugar-beet crop is one that will justify the investment in fertilizer.

The methods and systems of fertilization are so various and so dependent upon the character of the soil that it is hard to outline any particular kind. The requirements of the soil are like those of animals. They can not all be fed alike. There is a lack of some of the elements of plant food in some soils and an overabundance of other elements present in both the available and nonavailable state. Fertilizers promote plant life directly, and some indirectly, by breaking up compounds and freeing elements of plant nutrition which enter into other available compounds.

It is a truism to say that soils need a balancing by artificially supplying those elements of fertility which are lacking. This is especially true of the silt soils of the mountain States and the Pacific coast. The deficiency is best supplied by the introduction of commercial fertilizers. Many of our soils are lacking in humus; they may be rich in mineral plant foods, while at the same time they are poor in mechanical structure. Such soils need to be reenforced by the compost heap and by decaying vegetable matter. Without humus they dry out and become hard and sterile. Moisture is the agent of solution and circulation, the solvent and common carrier of plant food.

Many soils are deficient in nitrogen, which is supplied both through commercial fertilizer and decaying vegetable and animal matter. Barnyard manure offers a ready means for fertilizing the soil, and one which every farmer can employ. Much has been said and written upon this subject, and with a common accord favorable to

its use. There has been considerable difference of opinion, however, as to the time and methods of its application for beets. I think much of this disagreement is due to the different requirements of the various soils. Probably barnyard manure is good for all kinds of soil on which sugar beets are grown. As to the time of its application I do not care to make a suggestion, except that the farmer should experiment with his soil, study the action of similar soils, and follow his best judgment. Any farmer can largely increase his supply of barnyard manure by a methodical effort. I wish to call attention to the helpfulness of a sugar factory in this particular. Through the pulp produced by it and beet leaves and beet tops left in the fields the sugar factory makes possible a large increase in the number of animals kept on the farm. These by-products afford abundant stock food and stimulate animal production.

The farmer takes a load of beets to the factory and takes home a load of pulp. He gathers his beet leaves or stores them or mixes them with pulp, in a silo made for that purpose. Both the pulp and the leaves are good for young animals, fattening animals, and dairy cows. The barnyard manure should be carefully preserved and taken back to the land, increasing the humus and supplying nitrogen and other plant foods. The sugar factory has extracted the sugar, which is not a part of the soil's fertility. Assuming that he returns all of the manure resulting from feeding, the pulp from his beets, and the beet leaves of the crop, he has returned to the soil again all the fertility appropriated by the beets, except that assimilated by the animals. The farmer has intensified the productiveness of his lands and increased the profits of cropping. Every city or town affords a supply of barnyard manure. The citizens are glad to get rid of it. They will give it away, and sometimes they will pay for its removal. When a farmer takes a ton of beets to the factory he receives only a half ton of pulp in return. He will be able only to bring home half as many tons of pulp as he delivers tons of beets. But he need not return empty-handed; he can return half the time loaded with barnyard manure and distribute it on his farm. In this way he can haul a load from as well as to the factory, thus largely reducing the net cost of delivering the beets.

I have talked with thoughtful, progressive, and successful farmers who claim that a special trip for the average distance the farmers haul beets to the factory, made for the sole purpose of procuring manure from the towns of the vicinity, is highly profitable. If this be true, then in case he can return to the farm with a good load of manure after unloading his beets, it virtually costs him nothing to deliver a load of beets to the factory.

EXPERIMENTS WITH COMMERCIAL FERTILIZERS.

In the older beet-growing countries of Europe, where plans are arranged ahead for the manipulation of farms for a series of years, fertilization is one of the things most carefully considered. We are very little accustomed in the greater part of this country to the use of commercial fertilizers. In fact, we are not as much inclined that way as we should be, or as we will in years to come. I wish to insist, however, that we should not fail to resort to those methods of improving our soil now in use by every good farmer in our country, and known to everyone, whether he uses such methods or not. This is applicable to every crop, but it is especially so to the beets.

The Department of Agriculture has conducted experiments for several years past for the purpose of determining the value of various kinds of fertilizers on sugar beets. Last year, at the suggestion of the Secretary of Agriculture, a number of similar experiments were carried through on a somewhat larger scale than heretofore. In these experiments 10-acre fields of uniform soil were selected and divided into two equal parts. On one part 500 pounds of fertilizer per acre were used, while no fertil-

izer of any kind was used on the other. A ton of the fertilizer prepared for these experiments consisted of—

	Pounds.
Superphosphate	1,100
Sulphate of potash	400
Dried blood	500
	2,000

This mixture was used in Michigan, Utah, Colorado, and Washington States as representing to some extent the several sugar-beet sections. In several cases no reports of results were obtained, but the experiments reported upon showed a decided increase in tonnage, due undoubtedly to the action of the fertilizer. In addition to the increased tonnage, the beets on the fertilized soil contained more sugar and a higher coefficient of purity than the beets on the unfertilized soil. In one instance where a sandy loam was used the returns from the 5 acres that were fertilized amounted to $291.32, while the 5 acres that were not fertilized produced but $144.68 worth of beets, a clear gain of over $100 from the use of fertilizers on 5 acres of beets. it is confidently expected that this work will so encourage the growers of sugar beets that they will hereafter be enabled to obtain larger returns for the money and labor invested in sugar-beet production. In some sugar-beet sections the growers have already learned the value of good fertilizers and assert that they would not attempt to grow this crop without the application of plant food to the soil.

EXPERIMENTS WITH BARNYARD MANURE.

As throwing light upon the advisability of manuring a plat of ground used in growing sugar beets the same year they are planted, I offer the results of some very interesting experiments conducted by the State experiment station at Geneva, N. Y. These experiments were conducted for the following purposes: (1) Testing the results on the quality of beets grown on land to which stable manure has been applied in the spring prior to the crop; (2) testing the quality of the beets in comparison with beets grown on land receiving no manure; (3) testing beets grown on land receiving commercial fertilizer, compared with those grown on land receiving stable manure. On the plats receiving the commercial fertilizer, 1,000 pounds per acre was used; on plats receiving barnyard manure 40,000 to 80,000 pounds per acre was used. In either case beets gave better results with barnyard manure.

In growing beets it has been generally believed that it is a bad practice to apply fertilizers, especially barnyard manure, in the spring of the year of cropping. These experiments seem to show the reverse of this proposition.

These experiments, which were carried through four years, included the growing of beets from high-grade seed from various sources, at least six different varieties being used. The main question at issue in this work was the effect of commercial fertilizer and stable manure upon the manufacturing value of the beets, with especial reference to the possibility of depressing the quality of beets by growing them on land to which stable manure has been freshly applied. A determination of the percentages of sugar and of the coefficients of purity has been the means of judging of the quality of the beets grown. If beets may be standardized as to quality by the proportion of sugar in them, together with coefficient of purity, then the conclusions to be drawn from the data herewith presented are plainly indicated, as the table following will show.

General summary of results showing the influence of manure upon the quality of sugar beets, 1898–1901.

Year.	On plats which were not fertilized.		On plats which received commercial fertilizer.		On plats which received stable manure.	
	Sugar in beets.	Coefficient of purity.	Sugar in beets.	Coefficient of purity.	Sugar in beets.	Coefficient of purity.
	Per cent.		*Per cent.*		*Per cent.*	
1898	15.2	85.2	15.0	75.4	17.2	86.5
1898	15.6	81.6	15.0	79.4	15.9	80.8
1899	14.8	84.2	.....	.....	15.6	86.1
1900	.....	.....	14.2	83.6	15.2	84.7
1901	13.1	82.9	13.9	85.7	13.3	79.0

Attention is directed to the figures of the preceding tables, but more especially to the general summary in the table just given. The data here presented are strikingly opposed to what is regarded as the orthodox method of manuring sugar-beet land. It so happens that, with the exception of the crop of 1901, not only does the stable manure fail to depress the quality of the beets, but the crops grown where it was applied in the spring show a higher percentage of sugar than where commercial fertilizer was used or where no manure was applied. In 1901 the percentage of sugar was but little lower, but the coefficient of purity appeared to drop. But in this case the stable manure was used in an excessive quantity.

CONTRIBUTIONS FROM THE BUREAU OF PLANT INDUSTRY.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
Washington, D. C., February 14, 1905.

SIR: I submit herewith for publication as part of the report on Progress of the Beet-Sugar Industry in the United States for 1904 the following papers, prepared under my direction by experts of this Bureau who are conducting investigations with sugar beets: (1) Single-Germ Beet Seed, by C. O. Townsend; (2) Fertilizers and Sugar Beets, by C. O. Townsend; and (3) Commercial Sugar-Beet Seed, by J. E. W. Tracy.

Respectfully,

B. T. GALLOWAY, *Chief.*

Hon. JAMES WILSON,
Secretary of Agriculture.

SINGLE-GERM BEET SEED.[a]

By C. O. TOWNSEND, Pathologist, Bureau of Plant Industry.

INTRODUCTION.

The great amount of hand labor involved in thinning sugar beets, together with the scarcity of laborers competent and willing to do such work, makes exceedingly desirable any change in the beet which will have a tendency to eliminate part or all of this tedious work. The principal reason why hand labor is necessary in thinning the beets is that each of the beet seeds or balls planted usually contains from 2 to 7 germs, each of which may germinate and produce a plant. The plants arising from the germs of a multiple-germ seed ball stand in a compact bunch. In thinning, all but one of these plants must be removed, an operation which can be done only by hand. If, however, each beet seed contained but a single germ and these seeds were planted at regular short distances, it is evident that all or a large part of the thinning might be done with a hoe or other suitable implement. The fact that a small percentage of the seeds does contain single germs has led to an effort to

[a] For a complete record of the work to date see Bul. No. 73, Bureau of Plant Industry, U. S. Department of Agriculture, entitled: The Development of Single-germ Beet Seed. By C. O. Townsend and E. C. Rittue.

develop by selection a race or strain of beets having only single-germ seeds.

The attempt to develop a single-germ beet seed was taken up by the Department of Agriculture in the fall of 1902. The importance of developing a seed of this kind was set forth at that time in a paper by Mr. Truman G. Palmer,[b] secretary of the Beet-Sugar Manufacturers' Association; and the various objections to a beet seed of this kind were also discussed. The real value of a single-germ beet seed as a factor in sugar-beet production can be determined only by actual test when a sufficient quantity of the seed has been produced to make it possible to grow trial plots of beets produced from single-germ and multiple-germ seed under precisely the same conditions and in sufficient quantity to secure definite results on a commercial scale.

The first step of the Department of Agriculture toward the production of an increased percentage of single-germ beet seed consisted in the selection of a large number of single-germ seeds from commercial seed. It is noticeable that single-germ seeds are present in practically all commercial seed, but the percentage—usually about 1 per cent—is much smaller than is generally supposed. About 4,000 single-germ seeds were selected from eight varieties of commercial seed and planted on the farm of the Department of Agriculture at Arlington, Va., for the production of the first crop of seed beets. From the beets produced from the seed about 1,000 seed beets were selected and siloed, and these in turn were planted last season for the production of the first crop of seed.

FIG. 1.—Open beet flower showing number and arrangement of parts.

THE BEET FLOWER.

The beet flower consists of three sets of organs or parts arranged in three whorls, as shown in fig. 1. The outer whorl (A) consists of five green parts which are so arranged that they inclose and protect the other two sets of organs while the flower is in the bud stage. In

[b] See Report on Progress of the Beet-Sugar Industry in the United States for 1902.

the second whorl or circle of parts (B) there are five small double sacs supported on the ends of five filaments. These sacs, called anthers, contain the fine yellow dust called pollen. The central part of the flower (C) is called the pistil. When the pollen becomes ripe the anthers burst and the pollen is carried about by the wind or other agency, such as insects, etc. Some of the grains lodge upon the upper part of the pistil, which at the time becomes sticky and causes the pollen grains to adhere. Under proper conditions of warmth and moisture the pollen grains send out slender tubes which contain living matter, and which grow down into the lower part of the pistil where the living contents of the pollen tube unite with other living matter to form the germ of a new plant. The transfer of the pollen to the pistil is called pollination, and the union of the living contents of the pollen tube with the living matter in the lower part of the pistil is called fertilization. It appears that certain characters of the plant may be transferred by the pollen, and united with other characters contained in the pistil, so that the new plant produced by the union of these parts may possess characters of both parents; hence, it is important that plants selected for the development of single-germ seed shall possess the character of single-germ seed production in as high a degree as possible. With this point in view, those plants possessing the highest percentage of single flowers were selected for the production of the new generation of single-germ seeds.

FIG. 2.—Single beet flower at right and cluster of flower buds at left of stem.

The arrangement of the flowers on the seed stalks determines whether the seeds produced from the flowers are to bear single or multiple germs. If the flowers stand by themselves, as in fig. 2 (at the right), the seeds produced will be single-germ seeds, while if the flowers are borne in clusters, as in fig. 2 (at the left), the seeds will have multiple germs.

SINGLE AND MULTIPLE-GERM SEEDS.

A single-germ beet seed may be recognized by its more or less flattened and star-shaped appearance. The five green parts which make up the outer whorl of the flower spread out as the seed develops and form a part of the seed coat or hull, the tips of these parts forming the points of the star. These points often become broken off in

handling the seed, in which case a little closer examination is required to determine whether the seed has a single or multiple germ. In addition to the few single-germ seeds present in commercial seed, there are large numbers of seed balls containing from 2 to 7 germs each. These balls are readily recognized by their more or less rounded appearance, as the term "ball" indicates, and a close examination of these balls shows that they are made up of two or more seeds firmly welded together by their coats or hulls. It is possible for two single flowers to grow side by side on the flower stem without the seeds resulting from these flowers becoming united. As already indicated, it is only when the flowers grow in clusters that multiple-germ seed balls are formed. Each flower gives rise to but a single seed, so that even before the flowers are open one can tell whether the seeds that may be produced from the buds are to have single or multiple germs. For example, if the cluster is composed of three flowers and these flowers are properly pollinated and fertilized, a seed ball containing three germs will be produced.

Repeated efforts have been made to separate these multiple-germ balls into the several parts of which they are composed, but thus far this object has not been accomplished without destroying a large number of the germs or seeds. Even if this could be done, it is doubtful whether the whole object of single-germ seed production would be accomplished, since the single-germ seeds produced from single flowers show by several tests already made that the germination is quicker and the resulting seedlings are stronger then when multiple-germ balls are used. It is possible also that other good results may follow the use of single-germ seeds. This can be determined only by repeated comparison of the plants produced from single and multiple-germ seeds grown under the same conditions.

THE METHODS EMPLOYED.

In an effort to produce only single-germ seeds it is important that single flowers only be used in the production of seed, and that pollen from single flowers only be used to pollinate and fertilize the single flowers selected for seed production. With this end in view, 50 of the most favorable plants produced from single-germ seeds were selected and all flowers produced in clusters were removed. The single flowers left on the flower stalks were covered with paper bags to prevent pollen from the flower clusters of other plants from reaching the pistils of these single flowers, and then the whole plant was covered with a cloth bag to keep the paper bags from being blown off and to prevent the flower stalks from becoming whipped and injured by the wind. The work of isolating the single flowers was begun as soon as the buds were sufficiently formed to be easily handled, but before they were open. This was about June 15 and the work was continued until

July 4, when it was found that the flowers were opening on practically all the plants so generally that protection of the single flower from foreign pollen was no longer to be accomplished with certainty. A large number of the flowers thus isolated were pollinated with their own pollen; others were pollinated from single flowers from different parts of the same plant, and still other flowers were pollinated with pollen from single flowers from other plants. The seeds produced from the flowers thus treated were kept separate and will be planted by themselves this season for the production of seed beets for next year's crop of seed.

LOCATING THE SINGLE-GERM SEED EXPERIMENTS.

While producing the first crop of seed beets from single-germ seeds on the Government farm, tests were made with a number of seed beets for seed production. The object of these tests was to determine whether or not beet seed could be produced successfully in this locality. Soil and weather conditions seemed favorable and a large number of flower stalks were formed and an abundance of flowers was produced. Pollen was not lacking and bees and other insects were present throughout the flowering period, but when the seeds were gathered only a small percentage of the hulls contained germs or seeds.

The Utah Sugar Company, hearing of the proposed experiments, cordially invited the Department to continue the work on one of its farms near Lehi, Utah. The invitation was accepted and the seed beets were accordingly planted in that locality last spring. The results were in every way satisfactory and the experiments will be continued on the same farm on a more extensive scale this season. It is undoubtedly true that good results might be obtained along the line of these experiments in any one of a half dozen States where sugar beets are grown, but for several reasons it has been considered wise not to scatter the experiments, at least until a considerable quantity of single-germ seed has been produced.

RESULTS SO FAR ACCOMPLISHED.

When the work of isolating and pollinating the single flowers was finished it was found that the flowers on 50 plants had been isolated. These plants were naturally the best from the standpoint of the number of single flowers which they produced, but owing to the fact that it was necessary to remove the flower clusters in order to protect the single flowers from the pollen of the clusters, it was impossible to determine, even approximately, the percentage of single flowers produced by these 50 plants. It was noticeable that the number of single flowers on these selected plants varied among themselves within wide limits. However, when the seed was ripe all the seeds from a number

of plants that appeared to possess the highest number of single germs were gathered. The seed from each of these plants was kept separate and the percentage of single-germ seeds produced by 10 of these plants has been determined by actual count, and found to lie between 8.2 and 25 per cent, with an average for the 10 plants of 14.3 per cent. Ten plants having the highest number of single-germ seeds were selected from a 17-acre field of seed beets grown from ordinary beet seed. The seed from each of these plants was likewise kept separate and the percentage of single-germ seeds borne by them was determined and found to lie between 1.1 and 4.7 per cent, giving for the 10 plants an average of 2.7 per cent. An examination of a large quantity of commercial seed and of the siftings from commercial seed showed a still lower percentage of single-germ seeds. This was to be expected, since the 10 plants referred to were selected with a view to getting the best plants from the standpoint of "singles" in the commercial field. The average number of singles in the field would, therefore, be lower than is shown by the selected plants.

It is apparent, therefore, that the percentage of single-germ seed has been greatly increased in one generation by selecting single-germ seeds for the production of seed beets. It is the expectation of those having the work in charge to continue along the same line with the hope that by careful selection for several generations it will be possible to produce plants bearing only single-germ seeds.

FERTILIZERS AND SUGAR BEETS.

By C. O. Townsend, Pathologist, Bureau of Plant Industry.

According to the best information obtainable, the average weight of beets produced in the United States in 1903 was approximately 8 tons per acre. So far as the figures are in hand, the average weight per acre of the crop for 1904 seems to have been somewhat higher than in the preceding year, but still too low to give the financial results desired and expected when we remember that yields of 20 tons or upward per acre are not uncommon. It is the desire of the Department of Agriculture to aid the grower in every way possible in obtaining a higher average tonnage without injuring the quality of the beets. This when accomplished will result in a larger sugar production per acre, and therefore be mutually advantageous to the grower and to the manufacturer. It is only by maintaining and advancing these mutual relations between all parties connected with sugar-beet growing and beet-sugar production that the highest development of this industry can be attained. With this end in view the Department has endeavored, among other things, to investigate the effect of fertilizers upon sugar beets.

While this is one of the most important lines of work in connection with sugar-beet culture, it is one of the most complex problems with which to deal. In addition to the various kinds of fertilizer and fertilizer elements required, the combinations into which they may enter and the proportions in which they are needed by the plant, the soil and climatic conditions as affecting both the plant and its food are most important factors in determining the value of the fertilizer upon sugar beets.

SOIL.

Experience has shown that certain soils are better adapted to the production of sugar beets than are certain other soils. For example, clay loams and sandy loams give better results generally than are obtained from sand or muck soils. It is noticeable, however, that a clay loam does not always give the same results with the same crop. Aside from the climatic conditions affecting the growth of the plants, the physical and chemical composition of the soil varies from time to time in the same field, depending upon the method of treatment.

These variations when unfavorable should be corrected by proper cultivation, intelligent rotation, and judicious fertilization. The soil, when properly prepared for sugar beets, should be of a deep loamy nature, should contain a good supply of humus, and possess an abundance of available plant food. The nature of the subsoil, while extremely difficult to modify, is an important factor in determining the suitability of any field for growing sugar beets. The subsoil should be sufficiently permeable to allow proper drainage, but at the same time it should not be of such a nature as to allow the soil to leach, since the fertilizer applied would thereby be lost and the soil left too dry for good crop production.

CLIMATIC CONDITION.

It has been known for many years that high temperatures during the growing season are not conducive to the best results in sugar production in the beet. An examination of all the sugar-producing areas of Europe made by Doctor McMurtrie in 1879 and 1880[a] showed that the monthly average temperature for the growing months varied in these areas from approximately 50° to 70° F. The same writer determined the sugar-beet area of the United States on the same basis.[b]

The temperature and moisture of both soil and air must influence in some measure the effect of fertilizers upon the growing crop. The most marked effect of climate upon the usefulness of fertilizers is undoubtedly due to the moisture condition. This is indicated roughly in the Middle and Eastern States by the amount of rainfall and in some portions of the West by the amount of water applied in the process of irrigation.

It would seem that the irrigation method would be an ideal one under which to study the effect of fertilizer upon any crop; but such is not the case under the ordinary methods of irrigation, since the water is not evenly distributed, and usually there is no means employed for measuring the amount of water that is applied to any given area; nor is there usually any method used to determine the amount of water that evaporates and the amount which flows off the land and which, therefore, has no direct effect upon the soil or upon the fertilizer contained therein. It is clear to those who have considered the use of fertilizers in irrigated sections that little progress can be made in determining the real value of fertilizers upon sugar beets or other crops without measuring the amount of water that actually enters the soil during the growing season and without seeing to it that the same amount of water is evenly applied to both fertilized and control plats. In the rainy sections where sugar beets are grown the amount of rainfall

[a] Special Reports, Dept. of Agriculture, Vol. II, pp. 39 to 51.
[b] Loc. cit., pp. 51 to 59.

during the growing months is a very important factor. Unfortunately, however, it is a factor that is beyond our control, although much may be done to conserve the moisture after it has been taken up by the soil. In the sugar-beet sections the average monthly rainfall for the growing months varies from a small fraction of an inch to several inches. The total rainfall for each month is of less importance than the manner in which it is distributed, providing it is sufficient for the needs of the plant. Unless the rain is so distributed that the soil is kept sufficiently moist to maintain a constant supply of available plant food, whether originally in the soil or applied as fertilizer, the beets will become stunted, a condition from which it is difficult for them to resume normal growth.

The following table shows the average weather conditions in several localities where fertilizer experiments with sugar beets have been conducted during the past two seasons:

TABLE I.—*Climatic conditions in several sugar-beet sections.* (a)

1. LOWER LAKE REGION, 1903.

Month.	Temperature of air.			Total rainfall for month.	Maximum velocity of wind per hour.	Clear days.	Cloudy days.	Partly cloudy days.
	Average for month.	Maximum.	Minimum.					
	°	°	°	*Inches.*	*Miles.*			
April	46.9	79	22	5.51	41	13	10	7
May	60.8	87	28	1.55	48	13	6	12
June	62.8	86	47	6.32	30	5	12	13
July	72.6	92	50	4.59	40	9	2	22
August	67.4	84	47	4.27	31	7	9	15
September	64.1	88	41	2.78	31	10	6	14
October	53.1	75	28	1.67	41	13	11	7
November	36.4	71	13	1.18	36	5	18	7

2. NORTHERN PLATEAU, 1903.

April	44.8	76	26	.40	40	3	17	10
May	54.2	94	33	1.34	33	3	16	12
June	66.6	91	45	1.35	30	7	12	11
July	65.5	97	43	1.13	24	11	11	9
August	67.3	96	47	1.90	24	16	8	7
September	55.4	82	29	.83	33	9	16	5
October	49.2	72	28	.79	40	8	12	11
November	36.8	70	.....	1.4	24	1	3	26

3. LOWER LAKE REGION, 1904.

April	41.2	73	22	1.65	37	7	19	4
May	59.2	88	38	2.86	38	7	14	10
June	67	87	50	1.8	37	6	15	9
July	71.2	96	51	2.94	33	7	9	15
August	68.2	85	49	3.20	40	16	4	11
September	63.6	86	40	4.23	41	8	7	15
October	50.4	77	29	.86	42	8	14	9
November	40.1	68	16	.19	36	8	9	13

a These figures are taken from the monthly weather reports for the stations nearest the points where the experiments were conducted. Nos. 1 and 3 were taken from the Detroit, Mich., station, Nos. 2 and 4 from the Spokane, Wash., station, and No. 5 from the Omaha, Nebr., station.

TABLE I.—*Climatic conditions in several sugar-beet sections*—Continued.

4. NORTHERN PLATEAU, 1904.

Month.	Temperature of air.			Total rainfall for month.	Maximum velocity of wind per hour.	Clear days.	Cloudy days.	Partly cloudy days.
	Average for month.	Maximum.	Minimum.					
	°	°	°	*Inches.*	*Miles.*			
April	50.4	79	28	1.58	36	8	18	4
May	55.6	80	33	.13	30	5	18	8
June	61.8	93	37	1.24	35	11	9	10
July	69.8	98	45	.34	32	10	14	7
August	70.5	100	43	.10	24	19	2	10
September	60.7	91	37	.14	24	11	6	10
October	50.8	82	30	.77	24	11	12	8
November	44.0	64	24	.87	36	2	18	10

5. MISSOURI VALLEY, 1904.

April	45.8	73	24	3.20	46	15	11	4
May	62.0	88	38	4.86	32	10	13	8
June	69.1	90	51	3.11	32	5	13	12
July	73.1	93	54	3.15	36	12	5	14
August	72.4	93	54	4.45	33	16	9	6
September	66.3	89	42	2.60	37	12	13	5
October	56.6	87	32	1.40	40	12	13	6
November	44.8	70	21	.10	36	15	5	10

KINDS OF FERTILIZERS.

Fertilizers are divided naturally into three groups, namely, green manure, stable manure, and commercial fertilizer.

GREEN MANURE.

By green manure is meant any of those crops that are plowed under in a green condition. Usually leguminous crops (alfalfa, clover, peas, etc.) are used for this purpose. These leguminous crops store nitrogen in the soil in addition to their beneficial effects upon its physical condition produced by the addition of the humus which the tops and roots of the manurial plants produce in the process of decay. The use of green fertilizer implies some kind of a system of rotation, which is in itself an important factor in sugar-beet growing. It is true that beets have been grown on the same fields in some instances for more than a dozen years with good results. In these cases the fields have been properly cultivated and manured at frequent intervals, and serve to teach the important lesson that sugar beets do not injure the soil when it is properly treated.

Whatever the system of rotation, provision should be made for one leguminous crop. The system to be used and the leguminous crop to be employed in the rotation system must depend upon the locality. Probably no method of fertilizing is cheaper and more beneficial in proportion to its expense than green manuring. It is becoming a common practice in some parts of the West to plow up the alfalfa fields at regular intervals and plant them to beets. In one field of 100

acres that came under the writer's observation, alfalfa sod was plowed up in the spring and planted to beets. The yield was upward of 20 tons per acre, with a high sugar content and purity coefficient. It is desirable, however, in all possible cases where green fertilizers are to be used that they be plowed under in the fall, especially where additional humus is required.

It should be noted that green manures do not absolutely increase potash or phosphoric acid of the soil, although these deep-rooted plants do bring these substances nearer to the surface and make them more available for the root crops. Frequently, however, the addition of salts of potash and phosphorus is beneficial when applied in connection with the green fertilizers; and the fact should be emphasized that the humus produced by these green crops has a very decided influence in making commercial fertilizers effective.

STABLE MANURE.

Next in importance to the green manures is the stable manure. Unfortunately the supply of this material is limited in practically all our sugar-beet sections. The increasing use of beet pulp as a stock food has a tendency to encourage stock growing in the several sugar-beet localities, and this in turn increases the amount of stable manure. In some localities there is a strong prejudice against this form of fertilizer, on the ground that it tends to produce "rooty" beets. This may be true if fresh manure is applied in the spring; but only well rotted manure should be used in connection with sugar beets, and this should be applied to the soil and plowed under in the fall whenever practicable, although good results have been obtained by using well rotted manure in the spring, just before planting, and thoroughly harrowing it into the soil. The quantity applied must depend upon soil and climatic conditions, and also upon the kind of manure used. If the soil is deficient in humus, which unfortunately is the case on too many farms, a large quantity of stable manure should be applied; usually from 10 to 20 tons to the acre will be found satisfactory. No unfavorable reports have been received regarding the use of well rotted manure in connection with sugar beets. As in the case of green manure, stable manure may often be supplemented to advantage by the use of commercial fertilizers which contain potash, phosphoric acid, and nitrogen.

COMMERCIAL FERTILIZERS.

After the soil has been put in as good physical condition as possible by the rotation of crops, by the use of green and stable manures, and by thorough and timely cultivation, commercial fertilizers should be used, if necessary, to supply an additional amount of plant food. Whether or not the commercial fertilizer used should be a complete

fertilizer will depend upon the kinds and amounts of plant food already present in the soil in an available condition. In our experiments with fertilizers upon sugar beets during the past several years, both complete fertilizers and the compounds which go to make up these fertilizers have been used.

The following table will show some of the results obtained under different conditions with different kinds of fertilizers. The plats used varied in different experiments from 1 to 6 acres, but the results are computed on the acre basis for convenience in comparing them.

TABLE II.—*Experiments with a complete fertilizer on sugar beets.*

Number of plat.	Amount of fertilizer used per acre.	Composition of fertilizer.	Cost of fertilizer per acre.	Kind of soil.	Yield of beets per acre.	Sugar content of beets.	Purity coefficient.	Amount received per acre for beets.
	Pounds.				*Tons.*	*Per ct.*		
1	None.				6.14	18.9	89.4	$32.23
2	500	Dried blood, 125 pounds; sulphate of potash, 100 pounds; South Carolina rock, 275 pounds.	$16.00		7.13	19.7	90.4	37.73
3	None.			Sandy loam.	5.07	15.4	88.5	25.93
4	500	Dried blood, 125 pounds; sulphate of potash, 100 pounds; South Carolina rock, 275 pounds.	7.00	....do...	11.41	13.8	87.7	56.26
5	None.			Black loam.	14.22	16.1	85.3	63.99
6	325	Complete fertilizer, containing ammonia 1 to 2 per cent, potash 4 to 5 per cent, and phosphoric acid 8 to 10 per cent.	3.75	....do...	14.28	16.6	86.3	64.26
7	None.			Sandy loam.	5.89	15.5	Not given.	33.49
8	200	Complete fertilizer, containing nitrogen 1 to 2 per cent, potash 2 to 3 per cent, phosphoric acid 10 to 13 per cent.	2.50	....do...	7.57	15.9	Not given.	44.02

The first two experiments recorded above were conducted in 1903 and experiments 3 and 4 were carried on in 1904. Table I (part 2) shows the climatic condition under which experiment 1 of Table II was conducted. The small amount of rainfall will undoubtedly account in some measure for the low tonnage and for the slight increase due to the fertilizers. Several experiments not tabulated were conducted in the same locality in 1904 with no increase in tonnage or quality of beets in the fertilized over the unfertilized portions of the field. Table I (part 4) will show by its very low rainfall one reason for these results.

The difference in the cost of approximately the same fertilizers used in the different experiments was due mainly to the difference in transportation charges, since the cost per ton as given in the table is for the material laid down at the railroad station nearest the point where the experiments were conducted.

It will be observed that the fertilizers appeared to have no appreciable effect upon the sugar content nor upon the purity coefficient,

except in the second experiment, represented by plats 3 and 4, in which the sugar content was 1.6 per cent lower in the beets where the fertilizer was used. This difference was probably due to the fact that the beets on plat 3 were not harvested until about three weeks after the beets on plat 4. This gave the beets on the unfertilized plat a longer time to accumulate sugar, while the fertilizer seemed to ripen the beets so that the harvest could be begun earlier than would have been otherwise possible. This raises the question at once in regard to the advisability of early ripening at the expense of sugar content and how the unfavorable condition may be remedied.

In the first experiment it is seen that the sugar content was 0.8 per cent higher on the plat where the same kind of fertilizer was used. Undoubtedly soil and climatic conditions have fully as much to do with the sugar content as the fertilizer, and in some cases more. How to properly adjust the relation of the plant, the fertilizer, the soil, and the climate so that we shall get the best possible results under all circumstances is the great problem in sugar-beet culture.

In the foregoing experiments there was no difference in the purity coefficient in any case that could not be attributed to the usual difference in samples taken.

The amount received per acre for the beets shows an increase apparently due to the use of the fertilizer from twenty-seven cents to nearly $30. In the first experiment the gain was $5.50 per acre, but the cost of fertilizers per acre was $16. How much of the fertilizer remained in the soil and made itself felt in the next crop and how much was dissolved and carried away before the next crop was planted is not known; but clearly, so far as the sugar beets were concerned, the fertilizing was not profitable in dollars and cents. The same result was obtained in the third experiment represented by plats 5 and 6, although the rainfall here was sufficient, as shown by Table I (part 5). The second and fourth experiments gave returns far in excess of the cost of the fertilizer.

Several other experiments were planned for 1903, but for various reasons were not carried through. In the experiments for 1904 arrangements were made with the experimenters whereby they were to pay for the fertilizer or for that part of it indicated by the increased value of the beets where the fertilizer was used over that of an equal area where no fertilizer was used. Twenty-five experiments extending through the Eastern, Middle, and Western States were arranged on this basis, and, while the reports are not all in, the indications are that in the majority of cases the fertilizer produced no change either in the yield or quality of the beets and in some instances the tonnage was decidedly lower where the fertilizer was used. In no experiment was more than 500 pounds of fertilizer used per acre; and the same fertilizer that seemed to produce a falling off in ton-

nage in one case seemed in other cases to produce either an increase or no effect. This shows the importance of having a large number of experiments for comparison and also the importance of carrying such experiments through a long series of years in order to test the fertilizer under all possible conditions.

It is important also to know the effect of each of the elements that go to make up a complete fertilizer. It would seem that the first work should be to determine separately the effect of nitrogen, phosphoric acid, and potash upon the growth and quality of beets. During the past two seasons experiments have been conducted along this line, but necessarily on a small scale owing to scarcity of funds available for this work.

The following Tables, III and IV, show the results of two of the experiments:

TABLE III.—*The effect of nitrate of soda upon sugar beets.*

Number of plat.	Amount of fertilizer per acre.	Time of application of fertilizer.	Yield per acre.	Sugar content.	Purity coefficient.	Amount received per acre for beets.
	Pounds.		*Tons.*	*Per cent.*		
1	None.		7.53	15.6	86.1	$37.65
2	300	Just before planting	10.93	14.8	84.7	54.65
3	150	.....do	9.71	15.2	85.3	48.55
4	300	One-half just before planting and one-half July 1	11.03	15.1	86.7	55.15
5	300	July 1	10.82	15.4	85.7	54.10
6	150	.....do	10.20	15.3	85.2	51.00

TABLE IV.—*Effect of different amounts and different combinations of fertilizer elements on sugar beets.*

No. of plat.	Amount of fertilizer per acre.	Time of application of fertilizer.	Yield per acre.	Sugar content.	Purity coefficient.	Amount received per acre for beets.
			Tons.	*Per ct.*		
1	None		14.40	15.84	87.02	$72.00
2	Phosphoric acid 200 pounds, potash 100 pounds.	Just before planting, 1903.	15.26	15.48	86.96	76.00
3	Nitrate 200 pounds, phosphoric acid 200 pounds, potash 100 pounds.	.....do	18.20	15.97	87.33	91.00
4	Nitrate 100 pounds, potash 100 pounds.	.....do	14.12	16.64	83.60	70.60
5	Nitrate 100 pounds, phosphoric acid 200 pounds, potash 100 pounds.	.....do	17.98	15.58	87.60	89.90
6	Nitrate 100 pounds, phosphoric acid 400 pounds, potash 100 pounds.	.....do	16.46	15.60	87.07	82.30
7	Nitrate 100 pounds, phosphoric acid 200 pounds.	.....do	18.67	15.51	86.90	93.35
8	Nitrate 100 pounds, phosphoric acid 200 pounds, potash 200 pounds.	.....do	17.87	Not given.	Not given.	89.35
9	None		11.73	15.4	87.7	66.11
10	Phosphoric acid 200 pounds, potash 100 pounds.	Just before planting, 1904.	16.86	15.6	88.2	96.12
11	Nitrate 200 pounds, phosphoric acid 200 pounds, potash 100 pounds.	.....do	17.25	15.5	87.9	97.63
12	Nitrate 100 pounds, potash 100 pounds.	.....do	14.83	15.1	86.5	82.04
13	Nitrate 100 pounds, phosphoric acid 200 pounds, potash 100 pounds.	.....do	15.47	15.3	88.3	86.05
14	Nitrate 100 pounds, phosphoric acid 400 pounds, potash 100 pounds.	.....do	16.57	15.6	88.6	94.45
15	Nitrate 100 pounds, phosphoric acid 200 pounds.	.....do	16.56	15.6	87.5	94.40
16	Nitrate 100 pounds, phosphoric acid 200 pounds, potash 200 pounds.	.....do	16.69	15.4	76.8	94.05

Table III shows that nitrate of soda has a decided effect in increasing the value of beets per acre. This experiment has been repeated several times with similar results under varying conditions. It seems, therefore, that nitrate of soda is beneficial as a fertilizer for sugar beets under ordinary circumstances. A little better results were obtained by putting the nitrate on in two applications, as shown in plat 4, although when 300 pounds of nitrate were applied at one time the results were almost as good. The cost of the 300 pounds of nitrate, including its application, was approximately $9, so that in all cases where nitrate was used a decided financial gain resulted. It should be noted, also, that the nitrate did not apparently affect the sugar content nor the purity of the beets. In a few cases where larger quantities of nitrate were used the results were not appreciably better than when only 300 pounds per acre were applied. Whether or not this is a general rule can be determined only by repeated experiments.

Table IV gives in condensed form the results of identical experiments for two years on the same farm. Good results were obtained in each experiment by using 200 pounds of nitrate of soda, 200 pounds of phosphoric acid, and 100 pounds of sulphate of potash, as shown by results on plats 3 and 11. Plats 7, 8, 15, and 16 would indicate that the potash had no appreciable effect upon the quantity or quality of the beets, i. e., the results were just as good in plats 7 and 15, where no potash was used, as on plats 8 and 16, where 200 pounds of potash were applied. It should be noted in this connection, also, that none of these salts appeared to have any injurious effect upon the quality of the beets.

It would seem that by the extension and repetition of these experiments definite results can be reached in regard to fertilizers under different conditions, so that one can be reasonably sure of good results by the proper application of the right material at the proper time. Certainly, enough has been done to show that the yield of beets may be increased by the use of fertilizer without injuring the quality of the beets, and the experiments of the past season also show that much time and labor and money may be expended in using fertilizer without reaping any benefits therefrom. The cause of these failures may be in the fertilizers themselves, in the time or method of application, in the condition of the soil, or in the climatic conditions. The determination of this cause is a very important part of the fertilizer problem. Substances that are not directly fertilizers may often be of great benefit to sugar beets and other crops. Lime, for example, is an important constituent of the soil where sugar beets are to be grown, chiefly because of the physical effect that it exerts upon the soil. It is also sometimes advantageous to sow common salt upon land that is to be planted to sugar beets.

The following table shows some of the effects produced by salt when applied to the soil just before planting the beets:

TABLE V.—*The effect of salt upon sugar beets.*

Number of plat.	Amount of salt applied per acre.	Yield of beets per acre.	Sugar content.	Purity coefficient.	Amount received per acre for beets.
	Pounds.	*Tons.*	*Per cent.*		
1	None.	8.69	15.7	85.1	$43.45
2	200	11.18	15.6	85.5	55.90
3	300	10.05	15.7	84.4	50.25
4	500	10.79	15.7	84.7	53.95

Salt seems to have a beneficial effect in helping the soil to retain moisture. In some instances it seems to have no effect upon the yield. This would undoubtedly be true if there were plenty of moisture present normally. Two hundred pounds seem to be just as effective as 500 in increasing the yield, but even 500 pounds did not appreciably affect the quality of the beets. Only one grower who experimented with salt reported a decidedly lower tonnage and this must have been due to some cause other than the salt, since the lowest tonnage was not obtained from the plat where the largest quantity of salt was used. Some growers insist on using salt each year on their sugar-beet land, claiming that it not only increases the tonnage but that it holds the leaf-blight in check. This matter certainly deserves further investigation. The low price at which salt may be obtained makes it a very cheap indirect fertilizer if it proves upon further investigation to be beneficial.

The importance of continuing the work with fertilizers upon sugar beets is apparent, and it would seem from the results obtained that the foundation principles should first be determined, i. e., what fertilizer elements are most beneficial and what quantity should be used under the varying conditions of soil and climate. It is also important that the fields of beets under investigation should be completely under the control of the Department of Agriculture, so that the work of growing and harvesting the beets can be done in such manner and at such time as to give the most reliable information in regard to fertilizers and to furnish the most complete data possible for the solution of the problems involved.

COMMERCIAL SUGAR-BEET SEED.

By J. E. W. TRACY, Seed Expert, Bureau of Plant Industry.

There are 54 beet-sugar factories and 4 rasping stations now installed in the United States. These, together with several factories now in process of construction, call for the planting of more than 250,000 acres of land. The entire area planted to sugar beets in 1903 brought an average of nearly $42 per acre to the farmer who cultivated it, while the reported extraction was 11½ per cent, or 230 pounds of commercial sugar manufactured from every ton of roots worked throughout the United States.

The vast importance of the quality of the seed used, not only to the farmers but to the factories as well, can hardly be overestimated, for both the percentage of sugar in the root and the yield are largely dependent upon the quality of the seed planted.

In Germany, where the raising of sugar-beet seed and the manufacture of sugar have probably reached their highest development, this is considered of such importance that the most carefully managed factories insist upon having all the seed used by them grown under their own supervision, and on such soils and under such climatic conditions as experience has shown to be best adapted to their particular localities. Here, in America, comparatively little attention is paid to this matter, and largely in consequence certain factories have been financial failures because of this negligence as to the character of the seed they distributed to their growers. It is conservative to say that the average percentage of extraction in this country could be increased at least 2 per cent by the use of as high a grade of seed as the best used in Europe.

An increase of 2 per cent in the available sugar in the beet would make a difference of 40 pounds of refined sugar to each ton of roots worked, which, to a factory working 50,000 tons of beets a year, would mean an increase of 2,000,000 pounds of sugar. The total annual product of all the factories in the United States would be increased by more than 40,000 tons, which would mean the difference between profit and loss to many of them, as there need be no increase of capital tied up in their plants and only a slight increase in the total cost of production. Where a "flat rate"—a uniform rate for all roots regardless of their sugar content—is in vogue, there

would be no additional expense for the roots; but where a "sliding scale" is used, the price paid depending upon the sugar content, an increased cost of 50 cents per ton for roots would be incurred. The cost of hauling and slicing the roots and the extraction of the sugar would not be increased, while the chief additional expense would be in the purifying and handling of the finished product, both of which processes are comparatively inexpensive items in sugar manufacture.

The difference in the cost of the best and the cheapest grades of seed is rarely more than 4 cents a pound, so that if one planted 18 pounds of seed the additional expense would amount to but 72 cents to an acre. The reported average yield of roots per acre for the entire United States in 1903 was 8.4 tons, which, with an increase of 2 per cent in the available sugar, would give an increase of 336 pounds of sugar per acre at an additional cost for seed of only 72 cents. The total extra expense for the best seed for a 500-ton factory would be $3,600, while the sugar output would be increased 2,000,000 pounds, valued at some $90,000.

Seed which is sold as having been grown in the most careful and scientific manner is oftentimes actually the cheapest and poorest grade of seed procurable. It consists of both new and old seed, which has been grown under widely different conditions of soil and climate, and is mixed together by specially constructed machinery. It is explained that the different lots of seed are mixed to insure an evenness both in its germination and in the quality of the crop itself. The absurdity of mixing all kinds and grades of seed to produce uniformity in the crop is evident. It is generally admitted that the sugar beet, being one of our most highly bred plants, is very susceptible to the influences of both climatic and soil conditions; hence, seed should be used which has been so grown as to give the best results under the prevailing conditions of each particular location. All the beet seed imported is raised for the most part under very similar climatic and other conditions; but it is sown here in America under all conditions and in all soils—in New York and Michigan, Nebraska and Washington, and in the arid and semiarid regions of Utah and California—and it can not be the best for all of these varied localities. Seed raised on a particular soil and under certain climatic conditions may not be best suited for planting in like soils and under similar climatic conditions; in fact, very often it is not. Seed from comparatively poor soil may do best on rich soil, or that raised in the East may do best when sown in the West.

The best results in the sugar-beet industry can never be secured as long as there is carelessness as to the seed used. It is absolutely essential to success that the best quality of seed be secured, and past experience has conclusively shown that no dependence can be placed upon receiving such seed from abroad.

For several years efforts have been made to raise seed on a commercial scale in various sections of the United States, particularly in the

States of Michigan, Nebraska, Utah, Colorado, and Washington, but not until recently has any serious attempt been made to raise seed from pedigree roots, or in accordance with the scientific methods found to give the best results. It is of the utmost importance to the beet-sugar industry that we establish a high-grade strain of seed from which all the seed used in the United States may be grown in this country and in such a careful, scientific manner that it will not only be of the best quality, but will have such characteristics as will make it adapted to the particular needs and requirements of the locality where it is to be sown.

THE ESTABLISHMENT OF A PEDIGREE STRAIN OF SUGAR-BEET SEED.

The Department of Agriculture, realizing the importance of the foregoing facts to the sugar-beet industry of the United States, has undertaken to assist in the establishment of such a pedigree strain of sugar-beet seed and to determine the environmental influences of the different sections upon this strain. This work has been established in connection with the New York experiment station at Geneva, the Michigan experiment station at Agricultural College, Mich., and the Utah experiment station at Logan, and also with private growers under departmental supervision at Holland, Mich., and at Fairfield, Wash.

As this work has only recently been started, no definite report can be given at this time as to the final results, but an outline of the general plan of the work as it is being done at each of the above-mentioned stations is given, for not only are the same lots of seed tested at each station, but the manner of conducting the experiments, taking the samples for analyses, and making the analyses are also identical. In short, no effort is spared to make the experiments at each station an exact duplicate of those at each of the other stations.

When the work was first begun, the best strains of European seed obtainable and all known strains of American-grown seed were secured and sown in tracts varying in size from one-tenth to one-half acre, depending upon the amount of seed available and the supposed relative value of each. During the fall, analyses of samples were made at frequent intervals to determine the relative time of ripening of each lot, as well as its respective merits as to sugar content and purity. The four strains which showed the highest sugar content and purity and whose roots were of the best size, shape, color, etc., were decided upon for use as foundation stocks from which to build up superior strains of seed. A large number of roots from each of these four lots were then selected as to shape, size, color, and other external characteristics, and each one was individually analyzed. Each root found of exceptional quality was carefully noted, numbered, and siloed for planting the coming spring as a "mother." In the

spring all the roots from each number showing the same sugar per cent and similar qualities were grouped and planted in one plot, each root retaining, however, its original number. Notes were taken throughout the growing season and the product of each root was harvested separately and given the original number of the "mother" root.

Last spring (1904) one-half of the seed of each root was sown separately and the products from each of these samples of seed which in composite test proved to be equal to or better than the "mother" root are now in silo at the various stations. They will be planted this spring to produce the first crop of Elite seed. The seed of the corresponding roots reserved the year before will be sown for the production of roots for next year's supply of Elite seed.

Last year some exceptionally fine lots of seed were secured from Germany, roots from which are now in silo at the various stations. It is very gratifying to know that some of the best roots now in silo were grown from a commercial lot of seed by a Washington State sugar-beet grower who has been engaged in sugar-beet seed production only four years. These include 15 roots testing 24 per cent sugar in the beet, 50 roots testing 23 per cent, and 100 roots testing 22 per cent; in all, some 300 roots testing 21 per cent or more of sugar in the beet, with composite tests showing coefficients of purity ranging from 86 to 91.9.

It is the purpose of the Department, as soon as a superior strain of seed has been fixed and established, to supply seed growers and factory men who may desire it with a supply for use as stock seed.

TEST OF THE COMPARATIVE MERITS OF VARIOUS VARIETIES.

In connection with the work of establishing a pedigree strain of sugar-beet seed the Department is carrying on in cooperation with the same experiment stations and individuals extensive comparative merit trials of all the varieties of sugar-beet seed which are used by two or more factories in the United States. The seed for this work was secured in 100-pound lots directly from the factories in original sacks to guarantee the testing of commercial samples and insure against testing prepared or selected samples of Elite seed. In making these tests every effort has been made to secure fields as uniform as possible in soil and other conditions, and no fields are used which have not been manured and cropped in the same manner for a number of years. Where there is the slightest difference as to soil, drainage, or physical properties, the rows are made to run so that no sample will be confined to the unfavorable ground. The sugar content and purity are determined from a composite test of 50 roots taken at intervals throughout the plat. The taking of such a large number of roots insures accuracy as to the true merits of the entire field. As these

composite tests are made of all plats several times during the ripening season it is possible to know when a variety is fully ripened and matured. The yield is computed from the entire tonnage secured from each plat, and not from small samples, as is often done.

While one year's test is not at all conclusive, the following average figures of the results secured at each station are given simply as those of a single year's observation.

These records will be added to from year to year, and will be reported upon later in detail either by the various stations or by the Department.

Results of variety tests of sugar-beet seed, season of 1904.

Variety.	Grower.	Sugar in juice.	Sugar in beet.	Coefficient of purity.	Yield per acre.
		Per cent.	*Per cent.*		*Tons.*
Kleinwanzlebener	Utah Sugar Co., Lehi, Utah	19.7	17.6	87.2	10.98
Do	E. H. Morrison, Fairfield, Wash.	19.5	16.6	87.9	13.17
Do	American Beet Sugar Co., Grand Island, Nebr.	19.9	16.5	86.6	10.44
Do	C. C. Morse & Co., Santa Clara, Cal.	17.7	15.0	83.7	11.53
Do	H. C. & J. B. Agnew & Co., Agnew, Cal.	19.0	15.7	85.1	11.49
Original Kleinwanzlebener.	Kleinwanzlebener Sugar Co., Kleinwanzlebener, Germany.	19.8	16.8	86.6	9.92
Elite Kleinwanzlebener	Otto Bruenstedt & Co., Schladen Am-Hartz, Germany.	19.2	16.8	86.1	10.50
Do	Dippe Bros., Quedlinburg, Germany.	20.2	17.1	86.2	10.79
Do	C. Braune & Co., Blendorf, Germany.	19.1	15.8	84.6	11.64
Kleinwanzlebener	Henry Mette & Co., Quedlinburg, Germany.	18.2	16.1	86.5	11.29
Do	F. Heine & Co., Hadmersleben, Germany.	19.8	17.0	86.0	10.43
Do	Kulm & Co., Naarden, the Netherlands.	19.6	17.0	86.6	10.49
Do	Otto Hoerning & Co., Eisleben, Germany.	18.1	15.9	85.5	11.20
Aderstadt	Knauer & Co., Grobers, Germany.	18.3	15.9	84.7	9.95
Jaensch Victrix	Gustav Jaensch & Co., Ascherleben, Germany.	18.5	16.0	86.6	9.71
Schreiber's Specialitäte	G. Schreibers & Sons, Norhausen, Germany.	20.6	16.9	87.3	10.72
Knauer's Mangold	M. Knauer & Co., Grobus, Germany.	18.0	15.2	85.4	10.32

COMMERCIAL TEST OF AMERICAN AND FOREIGN-GROWN SEED.

Last year the Department of Agriculture secured some 4,000 pounds of California-grown and 11,000 pounds of Washington-grown Kleinwanzlebener sugar-beet seed, all of which was distributed throughout the sugar-beet-growing sections of the United States for the purpose of comparing the results obtained under ordinary cultural conditions from this American-grown seed and those secured by the use of the seed furnished to farmers by the factories.

While some of this seed was sent directly to the factories, the greater part was placed with farmers within hauling distance of the factories, who had been recommended to the Department by the factory agriculturists as being the most painstaking and best suited for this line of

work. In placing this seed each farmer was interviewed, when the exact nature of the work was explained to him and the requirements in preparing the soil and in planting and caring for the crop were discussed.

As a rule, seed was only supplied to farmers who were planting at least five acres of beets and who had available fields of at least this extent which were uniform in texture and physical properties and had been cropped and manured in the same manner for a number of years. Occasional exceptions were made in cases where farmers planted but two or three acres, providing they were especially recommended by their respective factory managers. In every case the available land was measured and staked off, one-half to be sown with seed furnished by the Department and the remainder with seed furnished by the factory. With few exceptions no individual was given more than enough seed to plant five acres. Before harvest time, each farmer was again visited and a personal inspection was made of his field. Where it was found that both lots of seed had not been sown and cared for in such a manner as to insure a good comparative test, note was made of the fact and later either his reports were eliminated or corrected by discarding the data from the objectionable portions of the field.

Two blanks for reports were sent to each experimenter. The first, which was sent early in June, covered the following points:

Seed furnished by the Department:
Date of planting, ———. Area planted, ———.
Amount of seed sown per acre, ——— pounds. Date of thinning, ———.
Width between rows, ———. Distance apart in row, ———.
Stand secured, ———.
Seed furnished by the factory:
Date of planting, ———. Area planted, ———.
Amount of seed sown per acre, ——— pounds. Date of thinning, ———.
Width between rows, ———. Distance apart in row, ———.
Stand secured, ———.
Did or did not the seed furnished by the Department show quicker, stronger, and healthier germination? ———.
Other remarks, as to disease, insects, and climatic conditions: ———.

The second blank, covering the following additional points, was sent about harvest time:

Seed furnished by the Department:
Yield per acre computed from the entire area, ——— tons, ——— pounds.
If you harvested any portion of the field separately, what was the yield per acre? ——— tons, ——— pounds.
Reported tare, ———. Reported sugar content, ———. Reported purity, ———.
Seed furnished by the factory:
Yield per acre computed from the entire area, ——— tons, ——— pounds.
If you harvested any portion of the field separately, what was the yield per acre? ——— tons, ——— pounds.

Seed furnished by the factory—Continued.

Reported tare, ———. Reported sugar content, ———. Reported purity, ———.

Did or did not the field grown from seed furnished by the Department show a stronger and healthier growth throughout the growing season? ———.

Kindly add any remarks regarding the comparative quality of the two lots of seed grown by you: ———.

A review of these reports shows that 73 per cent of those planting the Washington-grown seed and 64 per cent of those planting the California-grown seed found it to be of quicker, stronger, and healthier germination, while none found it inferior to the seed furnished by the factories in these respects. While the returns have not all been received, those from 561 acres show that the sugar content of beets from the Washington-grown seed was 15.4 per cent, and that of beets from California-grown 14.4 per cent, as against 14.9 per cent for beets from the factory seed; and a yield of 10.7 tons for the Washington seed, 9 tons for the California seed, and 9.1 tons for the factory seed. This work will be continued the coming year with the Washington-grown seed, and, as far as possible, with the same men.

THE EFFECTS OF VARIOUS QUANTITIES OF WATER UPON THE QUALITY OF SEED.

In addition to the above work this Department is cooperating with the Utah Agricultural Experiment Station at Logan, Utah, in carrying on experiments to determine the effect, if any, of various quantities of water applied at different times for irrigation purposes upon the permanent qualities imparted to seed. This work, while in its infancy, shows some remarkable results, which will be announced later by the station and the Department.

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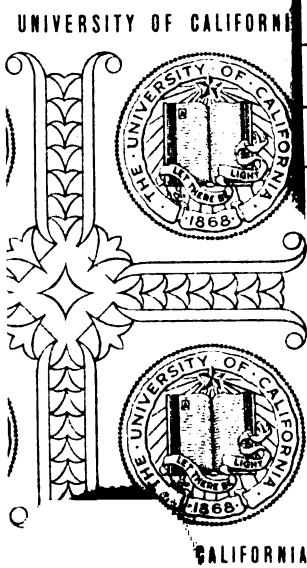

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